United States Department of Agriculture

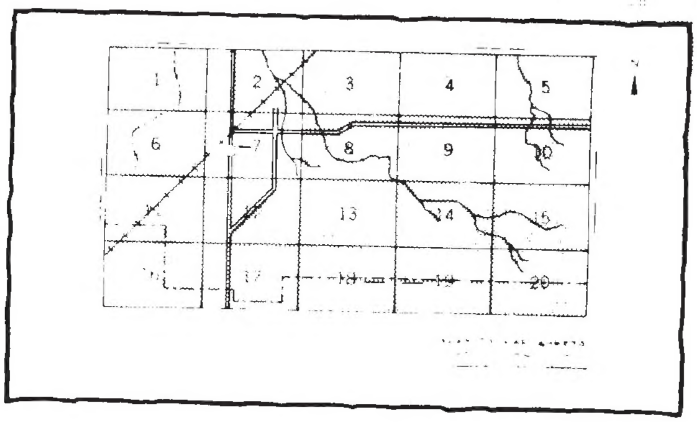
Soil Conservation Service

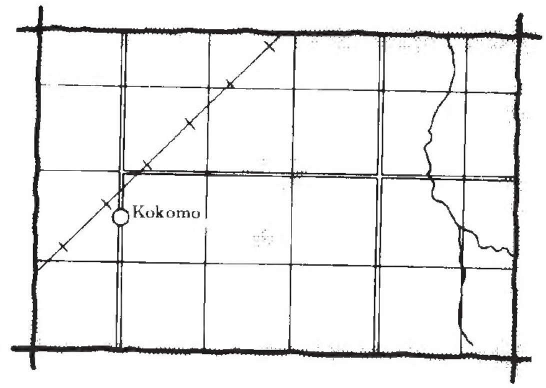
In Cooperation with Michigan Agricultural Experiment Station

Soil Survey of St. Joseph County Michigan

HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).





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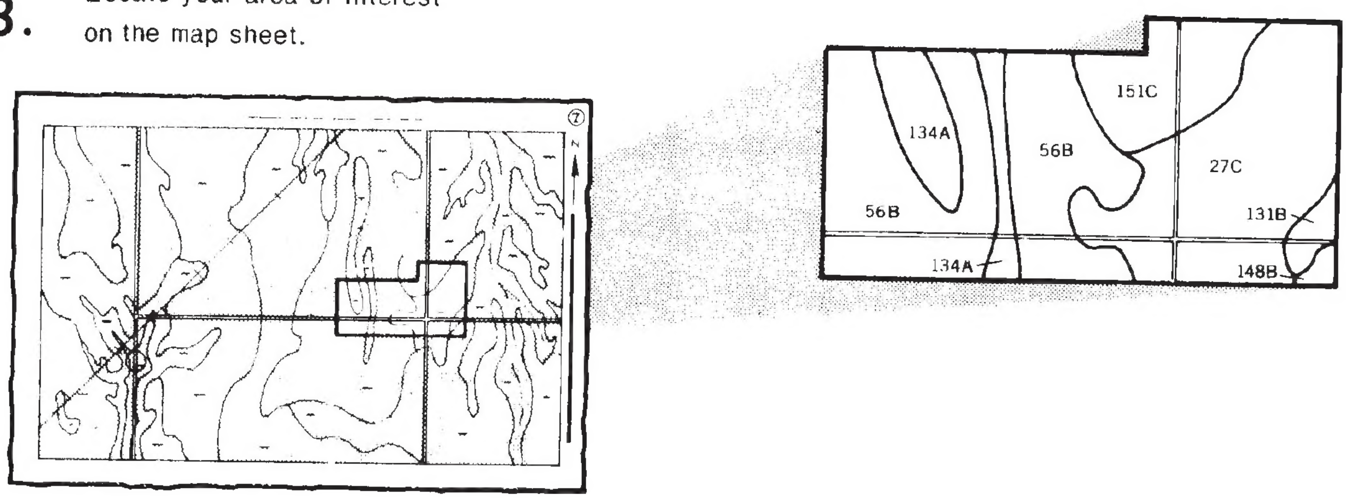

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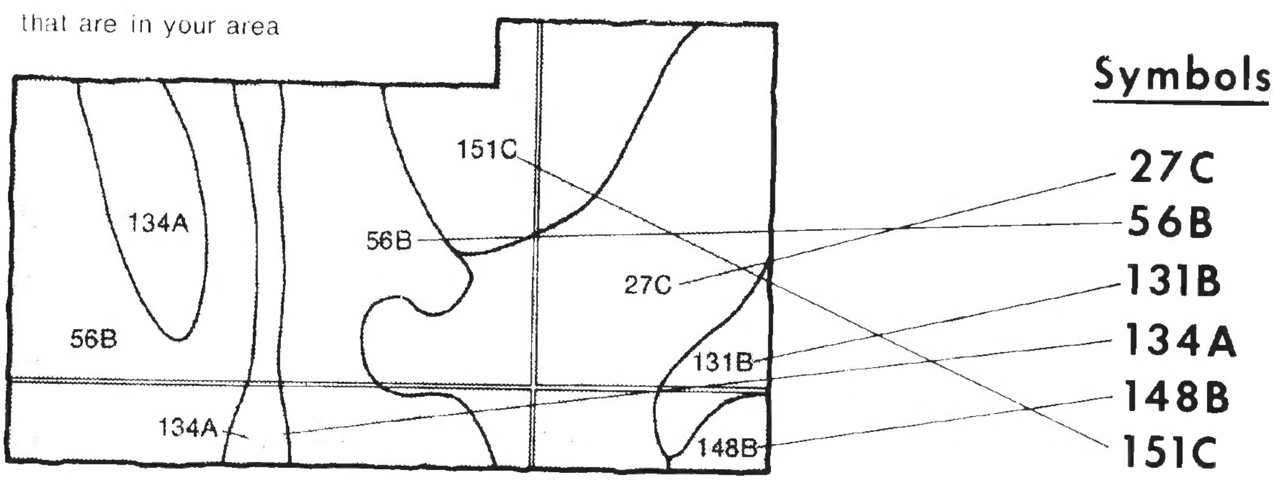
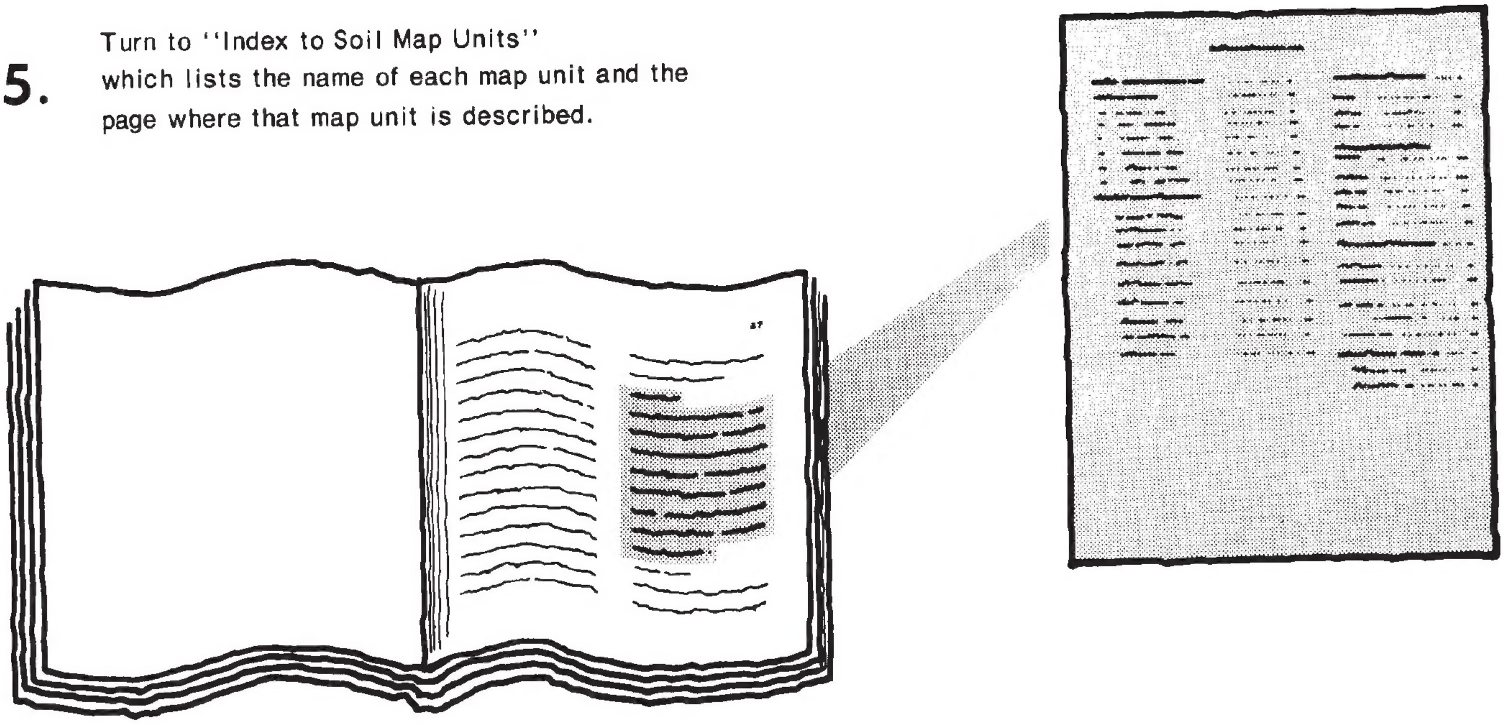
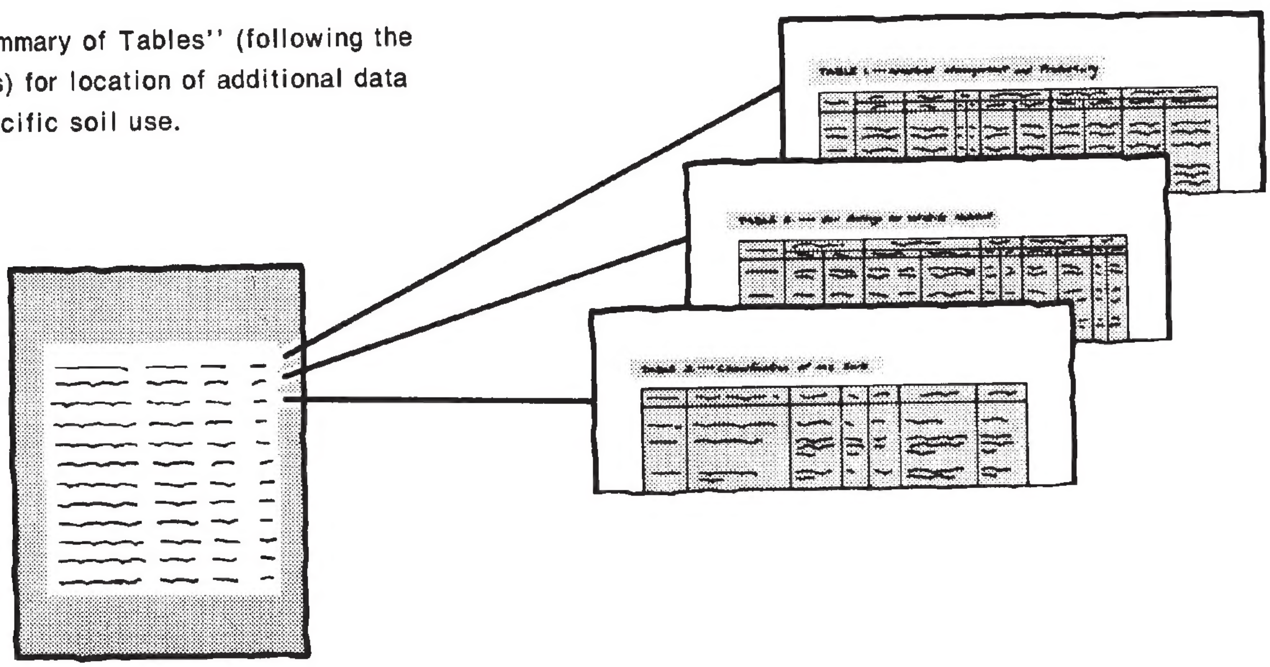


THIS SOIL SURVEY

5. Turn to ''Index to Soil Map Units'' which lists the name of each map unit and the page where that map unit is described.



6. See ''Summary of Tables'' (following the Contents) for location of additional data on a specific soil use.



7. Consult ''Contents'' for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Michigan Agricultural Experiment Station. It is part of the technical assistance furnished to the St. Joseph County Soil Conservation District. Financial assistance was provided by the St. Joseph County Board of Commissioners. Major fieldwork was performed in the period 1976-1980. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

This soil survey supersedes the soil survey of St. Joseph County published in 1923.

Cover: Corn is one of the major crops in St. Joseph County, and irrigation on the more droughty soils nearly doubles the yield. This soil is Elston sandy loam, 0 to 3 percent slopes.

contents

Index to map units ... iv
Summary of tables ... v
Foreword ... vii
General nature of the county ... 1
How this survey was made ... 3
General soil map units ... 5
  Soil descriptions ... 5
  Broad land use considerations ... 10
Detailed soil map units ... 11
  Soil descriptions ... 11
Prime farmland ... 29
Use and management of the soils ... 31
  Crops and pasture ... 31
  Woodland management and productivity ... 35
  Windbreaks and environmental plantings ... 36
  Recreation ... 37
  Wildlife habitat ... 37
  Engineering ... 38
Soil properties ... 43
  Engineering index properties ... 43
  Physical and chemical properties ... 44
  Soil and water features ... 45
Classification of the soils ... 47
Soil series and their morphology ... 47
Formation of the soils ... 59
  Factors of soil formation ... 59
  Processes of soil formation ... 60
References ... 63
Glossary ... 65
Tables ... 73

soil series

Adrian series ... 47
Barry series ... 48
Brady series ... 48
Bronson series ... 49
Cohoctah series ... 50
Elmdale series ... 50
Elston series ... 51
Granby series ... 51
Hillsdale series ... 52
Houghton series ... 52
Kalamazoo series ... 53
Matherton series ... 53
Nottawa series ... 54
Oshtemo series ... 54
Palms series ... 55
Riddles series ... 55
Schoolcraft series ... 56
Sebewa series ... 56
Spinks series ... 57
Teasdale series ... 57

Issued April 1983

index to map units

2—Histosols and Aquents, ponded 11
4B—Oshtemo sandy loam, 0 to 6 percent slopes 12
4C—Oshtemo sandy loam, 6 to 12 percent slopes 13
4D—Oshtemo sandy loam, 12 to 18 percent slopes 13
5B—Spinks loamy sand, 0 to 6 percent slopes 14
5C—Spinks loamy sand, 6 to 12 percent slopes 14
5D—Spinks loamy sand, 12 to 18 percent slopes 15
8A—Nottawa sandy loam, 0 to 3 percent slopes 15
9A—Elston sandy loam, 0 to 3 percent slopes 15
10B—Hillsdale sandy loam, 2 to 6 percent slopes 16
10C—Hillsdale sandy loam, 6 to 12 percent slopes 16
10D—Hillsdale sandy loam, 12 to 18 percent slopes 17
12A—Brady sandy loam, 0 to 2 percent slopes 18
13—Granby sandy loam 19
14—Sebewa loam 19
15—Cohoctah loam 20
16B—Elmdale sandy loam, 1 to 6 percent slopes 20
17B—Teasdale sandy loam, 0 to 4 percent slopes 21
18—Barry loam 21
19—Houghton muck 22
20A—Bronson sandy loam, 0 to 3 percent slopes 22
21A—Matherton loam, 0 to 3 percent slopes 22
24—Adrian muck 23
25—Pits 23
26—Palms muck 23
27B—Kalamazoo loam, 0 to 6 percent slopes 24
27C—Kalamazoo loam, 6 to 12 percent slopes 24
28B—Riddles sandy loam, 2 to 6 percent slopes 25
28C—Riddles sandy loam, 6 to 18 percent slopes 25
29B—Schoolcraft loam, 0 to 4 percent slopes 25
30B—Urban land-Oshtemo complex, 0 to 6 percent slopes 26
31B—Udorthents, loamy 26
32—Dumps 26
33A—Urban land-Elston complex, 0 to 3 percent slopes 26

summary of tables

Temperature and precipitation (table 1) 74
Freeze dates in spring and fall (table 2) 75
Probability. Temperature.
Growing season (table 3) 76
Acreage and proportionate extent of the soils (table 4) 77
Acres. Percent.
Capability and yields per acre of crops (table 5) 78
Capability subclass. Corn. Corn silage. Soybeans. Legume hay. Oats. Winter wheat.
Capability classes and subclasses (table 6) 80
Total acreage. Major management concerns.
Woodland management and productivity (table 7) 81
Ordination symbol. Management concerns. Potential productivity. Trees to plant.
Windbreaks and environmental plantings (table 8) 84
Recreational development (table 9) 87
Camp areas. Picnic areas. Playgrounds. Paths and trails. Golf fairways.
Wildlife habitat (table 10) 89
Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife.
Building site development (table 11) 91
Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets. Lawns and landscaping.
Sanitary facilities (table 12) 94
Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.
Construction materials (table 13) 97
Roadfill. Sand. Gravel. Topsoil.
Water management (table 14) 99
Limitations for—Pond reservoir areas; Embankments, dikes, and levees; Aquifer-fed excavated ponds. Features affecting—Drainage, Irrigation, Grassed waterways.
Engineering index properties (table 15) 101
Depth. USDA texture. Classification—Unified, AASHTO. Fragments greater than 3 inches. Percentage passing sieve—4, 10, 40, 200. Liquid limit. Plasticity index.

Physical and chemical properties of the soils (table 16) 104
Depth. Clay. Moist bulk density. Permeability. Available water capacity. Soil reaction. Shrink-swell potential. Erosion factors. Wind erodibility group. Organic matter.
Soil and water features (table 17)... 106
Hydrologic group. Flooding. High water table. Subsidence. Potential frost action. Risk of corrosion.
Classification of the soils (table 18)... 108
Family or higher taxonomic class.

foreword

This soil survey contains information that can be used in land-planning programs in St. Joseph County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Homer R Hilner

Homer R. Hilner
State Conservationist
Soil Conservation Service

Location of St. Joseph County in Michigan.

soil survey of
St. Joseph County, Michigan

By E. Selden Cowan, Soil Conservation Service

Fieldwork by E. Selden Cowan, Franklin R. Austin, and Dennis E. Hutchison, Soil Conservation Service
and Gregory F. Thoen, Ronald J. Church, Robert E. Evon, and William H. Hilton, St. Joseph County

United States Department of Agriculture, Soil Conservation Service
in cooperation with Michigan Agricultural Experiment Station

ST. JOSEPH COUNTY is in the southwestern part of the lower peninsula of Michigan. It borders Indiana on the south, Cass County on the west, Branch County on the east, and Kalamazoo County on the north. It covers an area of 323,584 acres, or 518 square miles. Centreville, the county seat, has a population of about 1,000. The population of St. Joseph County, in 1970, was about 47,392.

general nature of the county

This section provides general information about St. Joseph County. It discusses history and development, climate, physiography, relief, and drainage, and farming.

history and development

The settlement pattern in what is now St. Joseph County has been directly influenced by the natural features of the region—an extensive river system, abundant woodlands, and scattered prairies (*10*).

An agricultural people inhabited the prairies about 1,200 years ago. They are thought to have been a branch of the Hopewell Indian Mound Builders of the Ohio and Mississippi River Valleys (*6*).

French explorers and missionaries arrived in the 1660's. At that time, the Algonquin Indians had extensive settlements in the area.

White settlers came into the southern part of the county as early as 1813. Permanent settlement, however, did not occur until after 1821 when the Indians, by treaty, relinquished their rights to the land. The greatest migration was from the east, mainly from Ohio, Pennsylvania, and Virginia.

The prairies were the first areas to be farmed, but as the population increased, wooded land was cleared. Sawmills became prevalent along rivers, especially at the several points where rivers converge. The city of Three Rivers was established at such a site and grew as the commercial center of the area. In the southeastern part of the county, the city of Sturgis flourishes in an area that was one of the earliest agricultural centers in the area.

The county was established in 1829. Two years later, Centreville was established as the county seat.

climate

Prepared by Dr. Fred V. Nurnberger, Michigan Department of Agriculture, Weather Service, East Lansing, Michigan.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Three Rivers in the period 1949 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 26.2 degrees F, and the average daily minimum temperature is 18.4 degrees. The lowest temperature on record, which occurred at Three Rivers on February 12, 1899, is -20 degrees. In summer the average temperature is 70.2 degrees, and the average daily maximum temperature is 82.5 degrees. The highest recorded temperature, which occurred at Three Rivers on July 21 and 25, 1934, and again on July 13 and 14, 1936, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 33.97 inches. Of this, 20.45 inches, or 60 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 17.5 inches. The heaviest 1-day rainfall during the period of record was 3.94 inches at Three Rivers on July 21, 1976. Thunderstorms occur on about 36 days each year, and most occur in June and July.

Average seasonal snowfall is 45.6 inches. The greatest snow depth at any one time during the period of record was 27 inches. On an average of 64 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year. The heaviest seasonal snowfall was 65.4 inches in 1977-78, and the lightest was 13.5 inches in 1948-49. The heaviest 1-day snowfall on record was more than 18 inches. The amount of snowfall increases greatly to the west because of the influence of Lake Michigan.

According to data from the National Weather Service at Grand Rapids, Michigan, and at South Bend, Indiana, the average relative humidity in midafternoon in St. Joseph County is about 63 percent. Humidity is higher at night, and the average at dawn is about 82 percent. The sun shines 63 percent of the time possible in summer and 33 percent in winter. The prevailing wind is from the south-southwest. Average windspeed is highest, 12.3 miles per hour, in March. January is a close second, 12.1 miles per hour, and April is third, 12.0 miles per hour. The fastest windspeed was 63 miles per hour in August 1953.

According to data taken at South Haven, evaporation from an evaporation pan during the growing season (April through September) averages 33.6 inches. During the growing season, potential moisture evaporation exceeds average precipitation by 70 percent; thus, soil moisture replenishment during the fall and winter is important to the success of agriculture. Drought occurs periodically, but severe drought, as defined by the Palmer Drought Index, occurs only 6 percent of the time.

physiography, relief, and drainage

The dominant landforms in St. Joseph County are of glacial origin. In the northwest region, rolling moraines cover most of the northern part of Fabius Township and the central part of Flowerfield Township. In the morainic areas that have been cleared for farming, cobbles and stones of assorted sizes are common (fig. 1). There are gently rolling till plains in the eastern half of the county, particularly in the southeastern part in the townships of Sherman, Burr Oak, and Fawn River. In most of the county, however, broad, nearly level to undulating outwash plains are the dominant landform. The plains are the result of the deposits left by glacial melt waters in front of the ice.

There are also small areas of prairie soils, which are thought to have been part of the Great Prairies of the Midwest. The areas are concentrated in three regions: in the northeast, in parts of the townships of Mendon and Nottawa; in the southeast, immediately surrounding the city of Sturgis; and in the southwest, between the towns of Constantine and White Pigeon.

The St. Joseph River is the county's major drainageway. It flows in a southwesterly direction from the vicinity of the township of Leonidas, in the northeast corner of the county, to the western boundary of the township of Mottville, in the southwest corner.

The secondary rivers include the Portage and Rocky Rivers, which drain the north; the Prairie River, which flows across the central region from the east; and the Fawn and White Pigeon Rivers, which flow across the southern part of the county. They all feed into the St. Joseph River and, with the smaller tributary streams, form the county's drainage system.

There are numerous small ponds and bogs throughout the county, especially on the moraines and till plains where depressions were left by irregular glacial melt. There are many lakes along the rivers and streams on the outwash plains or concentrated on the moraines and till plains.

farming

Crop production is the primary land use in St. Joseph County. Corn and soybeans are the major crops. Wheat, oats, and rye are also grown. Specialty crops, including asparagus, spearmint, strawberries, and gladiolus, generally are grown on soils of limited capability. Seed

corn and popcorn are fairly new crops in the county but are taking up an increasing percentage of the farm acreage.

The number of beef and dairy cattle and of sheep in the county is steadily declining. Hog and poultry production, though not high, remains steady.

A current trend in local farming practices is toward overhead irrigation. In 1979, according to the Michigan Agricultural Statistics for that year, approximately 52,000 acres of cultivated crops was irrigated, a significant increase from 1969, when only 3,000 acres was irrigated. Irrigation is used most extensively in the broad, nearly level areas in the county, especially in areas of the more droughty soils. Irrigation, on the average, has doubled the yield of corn and soybeans on these soils.

The average size of farms in St. Joseph County has steadily increased, but the number of farms decreased by 12.6 percent from 1969 to 1974. During this period, approximately 5.5 percent of the land in farms was converted for other uses (*4,5*).

Figure 1.—Cobbles and stones in fence rows are common in morainic areas that are used as cropland.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

This soil survey supersedes the soil survey of St. Joseph County published in 1923 (*7*). This survey updates the earlier survey. It provides additional information and has larger maps that show the soils in greater detail.

Some of the boundaries on the soil maps of St. Joseph County do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modifications or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit, or soil association, on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

soil descriptions

1. Adrian-Granby association

Nearly level, very poorly drained and poorly drained mucky and loamy soils; in bogs and depressions and on outwash plains and lake plains

This association consists of depressions, flats, and drainageways on glacial lakebeds and the adjacent outwash plains (fig. 2). The slopes are 0 to 2 percent.

This association makes up about 3 percent of the county. It is about 50 percent Adrian soils, 40 percent Granby soils, and 10 percent soils of minor extent.

Adrian soils are in depressions and along drainageways. They are nearly level and are very poorly drained. Typically, the surface tier is black muck about 13 inches thick. The subsurface tier is black muck about 19 inches thick. The substratrum to a depth of about 60 inches is dark gray, mottled, loose sand.

Granby soils are in slightly higher positions. They are nearly level and are poorly drained or very poorly drained. Typically, the surface layer is black sandy loam about 11 inches thick. The subsurface layer is very dark gray, mottled loamy sand about 3 inches thick. The subsoil is dark gray and mottled and is about 14 inches thick. The upper part is friable sandy loam, and the lower part is very friable loamy sand. The substratum to a depth of about 60 inches is grayish brown, mottled, loose sand and fine sand.

The minor soils are Histosols and Aquents. They are ponded and are in lower concave areas.

The soils in this association are mainly in wetland vegetation, but in some areas they are drained and are used as cropland. The high water table and ponding are the major concerns. If these soils are drained, soil blowing is a hazard.

The soils in this association are well suited to use as habitat for wetland wildlife. If drained, they are suited to cultivated crops and specialty crops. The soils generally are not suited to sanitary facilities and building site development because of ponding and seepage.

2. Oshtemo-Spinks association

Nearly level to gently rolling, well drained loamy and sandy soils; on outwash plains and moraines

This association consists of soils on glacial outwash plains and moraines that are higher than the adjacent drainageways and lakebeds. The slopes range from 0 to 18 percent.

This association makes up about 65 percent of the county. It is about 45 percent Oshtemo soils, 20 percent Spinks soils, and 35 percent soils of minor extent.

Oshtemo soils are in nearly level areas along drainageways and on gently rolling knolls and ridges. They are well drained. Typically, the surface layer is dark grayish brown sandy loam about 9 inches thick. The subsurface layer is brown sandy loam about 5 inches thick. The subsoil is about 46 inches thick. The upper part is dark reddish brown and dark brown, friable sandy loam; the lower part is dark brown, loose loamy sand. The substratum to a depth of about 66 inches is grayish brown, loose, calcareous gravelly sand.

Spinks soils are on slightly higher ridges and along drainageways. They are nearly level to gently rolling and are well drained. Typically, the surface layer is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown loamy sand about 16 inches thick. The subsoil to a depth of about 60 inches is yellowish brown, loose sand that has bands of dark brown, very friable loamy sand.

The minor soils are Bronson, Brady, Granby, and

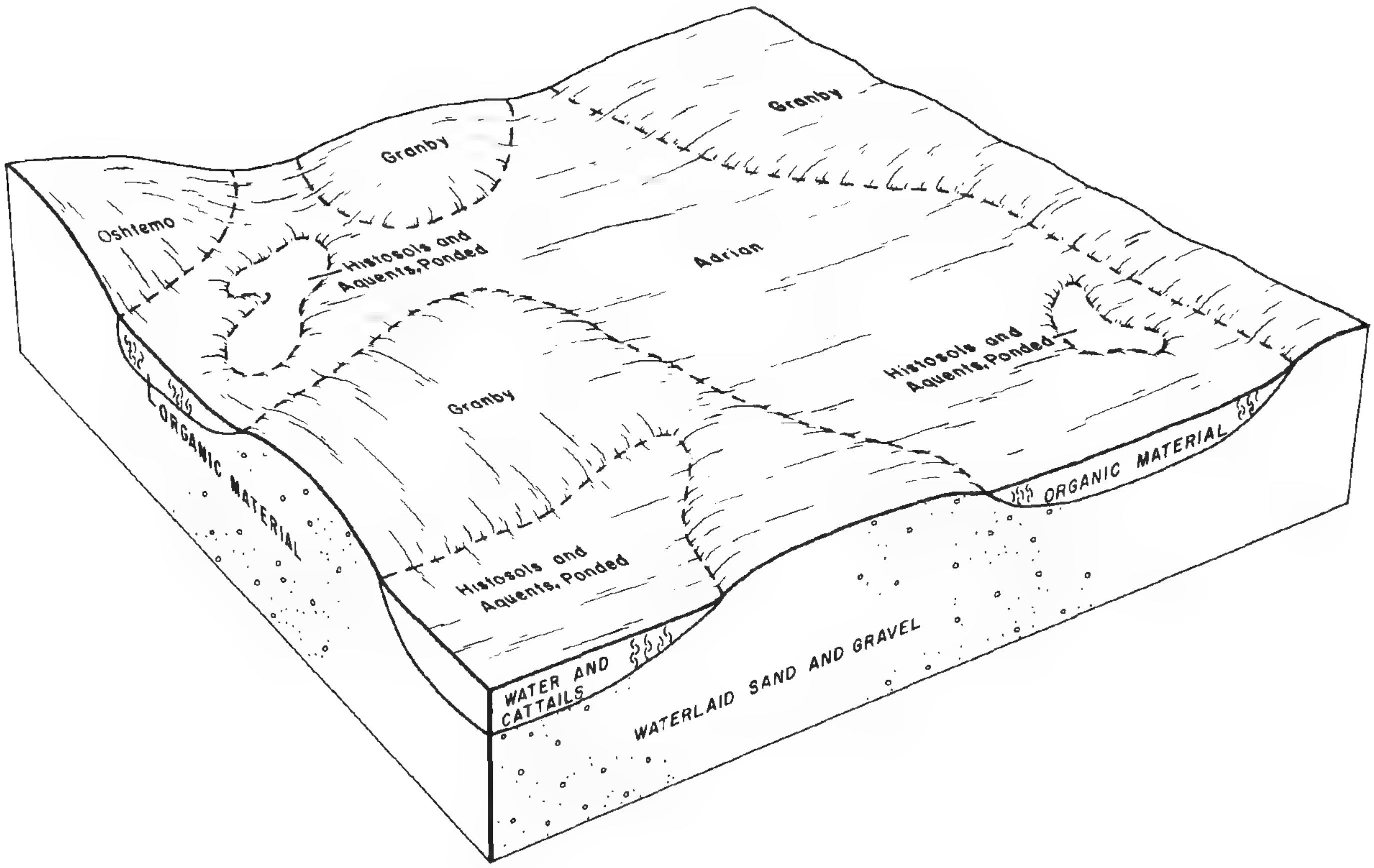


Figure 2.—Pattern of soils, topography, and underlying material in the Adrian-Granby association.

Houghton soils. The moderately well drained Bronson soils and the somewhat poorly drained Brady soils are in depressions. The very poorly drained Granby and Houghton soils are in drainageways.

The soils in this association are used mainly for cultivated crops (fig. 3). Some areas are used for specialty crops, and some small areas remain in native woodland. Droughtiness and soil blowing are the major concerns in management.

The soils in this association are suited to cultivated crops and to specialty crops, such as asparagus, gladiolus, seed corn, and popcorn. If soil moisture levels are low, irrigation can increase yields. The soils generally are suited to sanitary facilities and generally are well suited to building site development.

3. Hillsdale-Elmdale association

Nearly level to gently rolling, well drained and moderately well drained loamy soils; on till plains and moraines

This association consists of till plains and moraines that are dissected by drainageways, streams, and depressions (fig. 4). The slopes range from 1 to 12 percent.

This association makes up about 12 percent of the county. It is about 40 percent Hillsdale soils, 35 percent Elmdale soils, and 25 percent soils of minor extent.

Hillsdale soils are on nearly level to gently rolling knolls, side slopes, and ridges. They are well drained. Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is yellowish brown sandy loam about 35 inches thick. The upper part is friable, and the lower part is firm. The substratum to a depth of about 60 inches is yellowish brown, friable sandy loam.

Elmdale soils are on smooth uplands and foot slopes. They are nearly level to undulating and are moderately well drained. Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is friable sandy loam to a depth of about 60 inches. It is brown in the upper part and yellowish brown and mottled in the lower part.

The minor soils are Spinks, Teasdale, and Barry soils.

Spinks soils are well drained. They are on the steeper side slopes and foot slopes. Teasdale soils are somewhat poorly drained and are in positions on the landscape similar to those of Elmdale soils. Barry soils are poorly drained and are in depressions along drainageways.

The soils in this association are used mainly for cultivated crops. Some small areas remain in native woodland. Erosion and wetness are the major concerns in management.

The soils are well suited to cultivated crops and to use as woodland. Hillsdale soils are well suited to use as septic tank absorption fields and generally are suited to other sanitary facilities. Elmdale soils are poorly suited to use as septic tank absorption fields because of wetness. Seepage is the main limitation for sewage lagoons. The soils are well suited to building site development, although wetness is a limitation of the Elmdale soils.

4. Elmdale-Teasdale association

Nearly level and undulating, moderately well drained and somewhat poorly drained loamy soils; on till plains and moraines

This association consists of till plains and moraines that are dissected by drainageways, streams, and depressions. The slopes range from 1 to 6 percent.

This association makes up about 3 percent of the county. It is about 40 percent Elmdale soils, 40 percent Teasdale soils, and 20 percent soils of minor extent.

Elmdale soils are in slightly convex areas and on foot slopes. They are nearly level to undulating and are moderately well drained. Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is friable sandy loam to a depth of about 60 inches. It is brown in the upper part and yellowish brown and mottled in the lower part.

Teasdale soils are in broad nearly level areas, on rises, and along gently sloping drainageways. They are nearly level to undulating and are somewhat poorly drained. Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is pale brown sandy loam about 7 inches thick. The subsoil is about 35 inches thick. It is yellowish brown, mottled, and friable throughout. The upper part is sandy clay loam and loam, the middle part is sandy loam, and the lower part is loamy sand. The substratum to a depth

Figure 3.—Corn and soybeans are the major crops grown on soils in the Oshtemo-Spinks association.

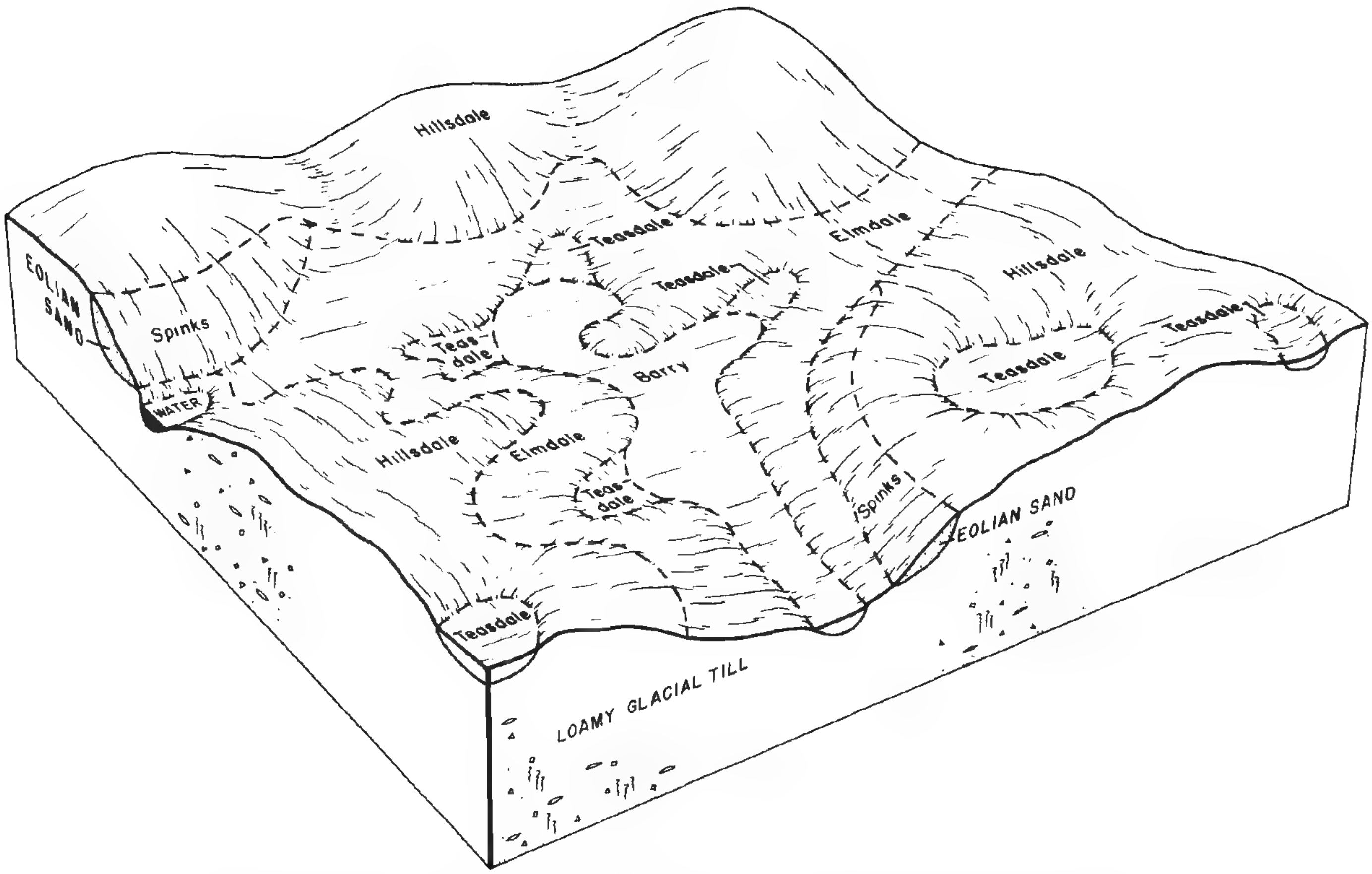


Figure 4.—Pattern of soils, topography, and underlying material in the Hillsdale-Elmdale association.

of about 60 inches is light yellowish brown, mottled, very friable, calcareous loamy sand.

The minor soils are Hillsdale and Barry soils. Hillsdale soils are on the higher knolls. They are well drained. Barry soils are in wet spots and drainageways and are poorly drained.

The soils in this association are used mainly for cultivated crops. Some areas remain in native woodland. Erosion and wetness are the major concerns in management.

The soils are well suited to cultivated crops and to use as woodland. They generally are poorly suited to sanitary facilities and building site development because of wetness and seepage.

5. Elston association

Nearly level, well drained loamy soils; on outwash plains

This association consists of glacial outwash plains that are higher than the adjacent glacial drainageways and lakebeds. The slopes range from 0 to 3 percent.

This association makes up about 3 percent of the county. It is about 75 percent Elston soils and 25 percent soils of minor extent.

Elston soils are nearly level and are well drained. Typically, the surface layer is black sandy loam about 10 inches thick. The subsoil is about 38 inches thick. The upper part is dark brown, friable sandy loam; the middle part is dark brown, very friable loamy sand; and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is pale brown, loose, calcareous sand.

The minor soils are Nottawa, Brady, and Granby soils. The moderately well drained Nottawa soils are within the prairie area of Mendon Township. They are in slightly lower positions adjacent to the Elston soils. The somewhat poorly drained Brady soils are on the side slopes of depressions. The very poorly drained Granby soils are in depressions and potholes.

The soils in this association are used mainly for cultivated crops. Soil blowing and droughtiness are the major concerns in management.

The soils are well suited to cultivated crops and to building site development. If soil moisture levels are low, irrigation can increase crop yields. The soils are suited to use as septic tank absorption fields, but the poor filtering

capacity is a limitation. The soils are poorly suited to use as sewage lagoons because of seepage.

6. Sebewa-Cohoctah association

Nearly level, very poorly drained and poorly drained loamy soils; on outwash plains and flood plains

This association consists of outwash plains, narrow flood plains, broad flats, depressions, and drainageways. The slopes are 0 to 2 percent.

This association makes up about 3 percent of the county. It is about 45 percent Sebewa soils, 35 percent Cohoctah soils, and 20 percent soils of minor extent.

Sebewa soils are on broad flats and slightly higher terraces. They are nearly level and are poorly drained or very poorly drained. Typically, the surface layer is black loam about 13 inches thick. The subsoil is dark gray and mottled. It is about 15 inches thick. The upper part is firm sandy clay loam, and the lower part is firm clay loam. The substratum to a depth of about 60 inches is gray, loose sand and grayish brown, loose gravelly sand.

Cohoctah soils are on nearly level, narrow flood plains. They are very poorly drained. Typically, the surface layer is black loam about 6 inches thick. The substratum is dark gray, mottled, friable loam in the upper 24 inches and dark gray, loose gravelly sand to a depth of about 60 inches.

The minor soils are Brady and Granby soils. Brady soils are in major drainageways on ridges and knolls and are slightly higher on the landscape than the Cohoctah soils. They are somewhat poorly drained. Granby soils are in positions on the landscape similar to those of the Sebewa soils. Granby soils are very poorly drained.

Sebewa soils are used mainly as cropland. In some areas they are used as woodland. Cohoctah soils are used as woodland, or they support wetland vegetation. Wetness and flooding are the major concerns in management.

Sebewa soils and Cohoctah soils generally are poorly suited to cultivated crops and to use as woodland. They generally are not suited to sanitary facilities and building site development because of ponding and flooding.

7. Kalamazoo-Oshtemo association

Nearly level to rolling, well drained loamy soils; on outwash plains and moraines

This association consists of glacial outwash plains and moraines that are higher than the adjacent drainageways and lakebeds. The slopes range from 0 to 18 percent.

This association makes up about 5 percent of the county. It is about 45 percent Kalamazoo soils, 35 percent Oshtemo soils, and 20 percent soils of minor extent.

Kalamazoo soils are in broad, flat areas and on lower side slopes. They are nearly level to gently rolling. Typically, the surface layer is very dark grayish brown loam about 12 inches thick. The subsoil is about 64 inches thick. The upper part is dark brown, firm clay loam. Below that, dark brown, friable sandy clay loam and sandy loam overlie dark brown, very friable loamy sand. The lower part is yellowish brown and dark yellowish brown, very friable loamy sand.

Oshtemo soils are on rises and side slopes and are slightly higher on the landscape than the Kalamazoo soils. They are nearly level to rolling. Typically, the surface layer is dark grayish brown sandy loam about 9 inches thick. The subsurface layer is brown sandy loam about 5 inches thick. The subsoil is about 46 inches thick. The upper part is dark reddish brown and dark brown, friable sandy loam; the lower part is dark brown, loose loamy sand. The substratum to a depth of about 66 inches is grayish brown, loose, calcareous gravelly sand.

The minor soils are Schoolcraft, Brady, Matherton, and Sebewa soils. Schoolcraft soils are in flat prairie areas and are well drained. Brady and Matherton soils are in depressions and drainageways. They are somewhat poorly drained. Sebewa soils are in potholes and are poorly drained or very poorly drained.

The soils in this association are used for cultivated crops in most areas. Some areas remain in native woodland. Soil blowing and droughtiness are the major concerns in management.

The soils are well suited to cultivated crops. If soil moisture levels are low, irrigation can increase crop yields. The soils are well suited to use as woodland. They are suited to use as septic tank absorption fields. However, poor filtering capacity is a limitation of Kalamazoo soils. The soils generally are well suited to building site development.

8. Hillsdale-Riddles association

Undulating to rolling, well drained loamy soils; on till plains and moraines

This association consists of moraines and till plains dissected by drainageways and streams. The slopes range from 2 to 18 percent.

This association makes up about 6 percent of the county. It is about 45 percent Hillsdale soils, 35 percent Riddles soils, and 20 percent soils of minor extent.

Hillsdale soils are on rolling side slopes and ridges. Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is yellowish brown sandy loam about 35 inches thick. It is friable in the upper part and firm in the lower part. The substratum to a depth of about 60 inches is yellowish brown, friable sandy loam.

Riddles soils are on undulating to rolling divides and side slopes. Typically, the surface layer is brown sandy

loam about 9 inches thick. The subsoil is about 46 inches thick. The upper part is dark brown, firm sandy clay loam; the middle part is yellowish brown, friable sandy loam; and the lower part is dark yellowish brown, friable sandy loam. The substratum to a depth of 60 inches is dark yellowish brown, very friable loamy sand.

The minor soils are Houghton and Spinks soils. Houghton soils are in drainageways and are very poorly drained. Spinks soils are on side slopes and are well drained.

The soils in this association are used mainly as cropland or woodland. In some areas they are idle. Slope is the major limitation.

The soils are well suited to use as woodland, and on the lower slopes they are suited to cultivated crops. They generally are poorly suited to sanitary facilities because of slope and seepage. The soils generally are suited to building site development; however, slope is a limitation.

broad land use considerations

Approximately 82 percent of St. Joseph County is agricultural land, 15 percent is woodland, and 3 percent is urban land. In general, the soils in the county have good potential for cultivated crops and for urban development. Corn and soybeans are the main crops grown in the county. Urban development is centered around the cities of Sturgis and Three Rivers and along most of the lakes and rivers.

The general soil map in this soil survey can be used in planning land use at the township or county level. The soils in all the associations on the map are used to some extent for cultivated crops. The soils in associations 5 and 7 are the best suited to farming. The soils in associations 2, 3, and 4 are suited to farming to a lesser degree.

The major soils in associations 2 and 7 are the Oshtemo, Spinks, and Kalamazoo soils. Droughtiness is the main concern on these soils, so irrigation is used to increase crop yields. Field size, however, is increased to accomodate the irrigation system, and increasing the size of the field increases the hazard of soil blowing.

The major soils in associations 3 and 4 are the Hillsdale, Elmdale, and Teasdale soils. Slope is the main limitation to use of the Hillsdale soils for farming, and wetness is the main limitation on the Elmdale and Teasdale soils.

If they are drained, the major soils in associations 1 and 6—Adrian, Granby, Sebewa, and Cohoctah soils—are suited to cultivated crops and to some specialty crops. The Cohoctah soils are subject to flooding. They generally are used as pasture during the summer. Seasonal ponding is the main hazard on the Adrian, Granby, and Sebewa soils.

The major soils in association 8—the Hillsdale and Riddles soils—are poorly suited to cultivated crops. Steep and complex slopes are the main limitations; erosion is a major concern.

The major soils in associations 2, 5, and 7 have few limitations for urban development. The importance of the soils for crops, however, should not be overlooked in making broad land use decisions. The main limitation of the soils for urban use is droughtiness during the summer, which affects lawns and trees. The soils are underlain by sand and gravelly sand; thus, seepage is a major problem. Suitable sites for sanitary facilities and landfills may not be available.

The major soils in associations 3 and 8 also are suited to urban development. The less sloping areas of Hillsdale and Riddles soils are suitable as sites for buildings.

The major soils in associations 1 and 6 generally are not suitable as sites for buildings or sanitary facilities. The soils in many undrained areas remain as marshes or are in brush and woods. In many places they are transected by streams and ditches. The soils pond in spring and after heavy rains. They provide suitable habitat for wetland wildlife.

The major soils in associations 3, 4, 7, and 8 are the best suited to timber production. Commercially valuable hardwoods are grown in many woodlots on these soils. Logging operations on the soils in association 4 may be restricted in the spring because of wetness.

The major soils in associations 1 and 6 generally are poorly suited to timber production because of wetness. Tree growth is slow on these soils, and seedling survival is low. The wetness also restricts logging operations. The species that are harvested are suitable mainly for pulpwood.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Oshtemo sandy loam, 0 to 6 percent slopes, is one of several phases in the Oshtemo series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Urban land-Elston complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Histosols and Aquents, ponded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

2—Histosols and Aquents, ponded. This map unit consists of nearly level soils in drainageways and depressions. In most areas, these soils are ponded all year, except during extremely dry periods. Histosols formed in organic vegetative material, and Aquents formed in alluvial sandy and loamy mineral material.

The individual areas of this map unit are irregular in shape and range from 3 to 600 acres in size. A mapped area can consist of only one of the soils, or it can consist of both soils.

Included with these soils in mapping are small areas of somewhat poorly drained Brady soils. Brady soils are in slightly convex areas; on the higher spots in broad, flat areas; and on the crests and ridges of depressions and drainageways. The included soils make up 2 to 10 percent of the map unit.

Most areas of these soils are cattail marshes that have willow and dogwood trees around the perimeter (fig. 5). Crops are not grown on these soils because the soils are under water most of the year, and most areas do not have drainage outlets. Trees do not grow well on these soils because of the ponding.

Figure 5.—Typical area of Histosols and Aquents, ponded.

These soils are not suited to building site development or to use as septic tank absorption fields or sewage lagoons. Wetness and ponding are the major limitations.

The capability subclass is VIIIw.

4B—Oshtemo sandy loam, 0 to 6 percent slopes. This is a nearly level to undulating, well drained soil on upland flats, side slopes, and foot slopes. There are short steep slopes and escarpments adjacent to waterways, lakes, and depressions. The areas are irregular in shape and range from 5 to 1,800 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 9 inches thick. The subsurface layer is brown sandy loam about 5 inches thick. The subsoil is about 46 inches thick. The upper part is dark reddish brown and dark brown, friable sandy loam; the lower part is dark brown, loose loamy sand. The substratum to a depth of about 66 inches is grayish brown, loose, calcareous gravelly sand. In some places, there is more than 20 inches of sand and loamy sand over the sandy loam. In some places, calcareous gravelly sand is at a depth of less than 40 inches.

Included with this soil in mapping are small areas of well drained Spinks soils, moderately well drained Bronson soils, and somewhat poorly drained Brady soils. Spinks soils are more droughty than Oshtemo soils and are in similar positions on the landscape. Bronson soils are in lower flat areas and in slight depressions. Brady soils are in depressions. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate, and runoff is slow or medium. The surface layer is very friable and is easily tilled within a fairly wide range of moisture content.

This soil is used mainly as cropland. It is suited to crops such as corn, soybeans, winter wheat, and alfalfa

hay. Soil blowing and droughtiness are the major concerns in management. Field windbreaks and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. Irrigation can increase the crop yield if soil moisture levels are low. If this soil is irrigated, the water application rate should be regulated, and equipment lanes should be seeded to control erosion.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is well suited to building site development and to use as septic tank absorption fields.

The capability subclass is IIIs. The Michigan soil management group is 3a.

4C—Oshtemo sandy loam, 6 to 12 percent slopes. This is a gently rolling, well drained soil on side slopes, knolls, and ridges. There are short steep slopes and escarpments adjacent to waterways, lakes, and depressions. The areas are irregular in shape and range from 5 to 600 acres in size.

Typically, the surface layer is dark brown sandy loam about 6 inches thick. The subsoil is about 44 inches thick. The upper part is dark brown, friable sandy loam; the middle part is yellowish brown, very friable loamy sand; and the lower part is yellow, loose loamy sand and dark yellowish brown, friable sandy loam. In some places, there is more than 20 inches of sand and loamy sand over the sandy loam. In some places, calcareous gravelly sand is at a depth of less than 40 inches.

Included with this soil in mapping are small areas of well drained Spinks soils, moderately well drained Bronson soils, and somewhat poorly drained Brady soils. Spinks soils are more droughty than Oshtemo soils; they are on ridgetops or on side slopes. Bronson soils are on foot slopes, and Brady soils are in depressions and along drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate, and runoff is medium. The surface layer is very friable and is easily tilled within a fairly wide range of moisture content.

This soil is used mainly as cropland. Many areas, however, are idle grassland or conifer plantations.

This soil is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion, soil blowing, and droughtiness are the major concerns. Grassed waterways and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. A cropping system that includes hay and small grains in the rotation also helps reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. Irrigation can increase crop yields if soil moisture levels are low. If this soil is irrigated, the water application rate should be regulated to control erosion, and equipment lanes should be seeded.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is suited to building site development and to use as septic tank absorption fields. Slope is the major limitation. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic tank absorption field.

The capability subclass is IIIe. The Michigan soil management group is 3a.

4D—Oshtemo sandy loam, 12 to 18 percent slopes. This is a rolling, well drained soil on side slopes and ridges. There are escarpments adjacent to waterways, lakes, and depressions. The areas are irregular in shape and range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 5 inches thick. The subsurface layer is yellowish brown, very friable loamy sand about 5 inches thick. The subsoil is about 50 inches thick. The upper part is strong brown, friable sandy loam. The lower part is loose sand that has bands of dark yellowish brown, friable sandy loam. In some places, calcareous gravelly sand is at a depth of less than 40 inches. In some places, there is more than 20 inches of sand and loamy sand over the sandy loam.

Included with this soil in mapping are small areas of well drained Spinks soils and somewhat poorly drained Brady soils. Spinks soils are on side slopes; they are more droughty than Oshtemo soils. Brady soils are in depressions and along drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate. Runoff is rapid.

Areas of this soil are mainly idle grassland or are used as woodland.

This soil is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion, soil blowing, and droughtiness are the major concerns in management. Grassed waterways and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. Cropping systems that include hay and small grains in the rotation also help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is poorly suited to building site development and to use as septic tank absorption fields. Slope is the major limitation. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic tank absorption field.

The capability subclass is IVe. The Michigan soil management group is 3a.

5B—Spinks loamy sand, 0 to 6 percent slopes. This is a nearly level to undulating, well drained soil in flat areas and on side slopes and foot slopes. There are short steep slopes and escarpments adjacent to waterways, lakes, and depressions. The areas are irregular in shape and range from 50 to 1,800 acres in size.

Typically, the surface layer is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown loamy sand about 16 inches thick. The subsoil to a depth of about 60 inches is yellowish brown, loose sand that has bands of dark brown, very friable loamy sand. In some places the surface layer is darker and thicker than is typical. In some places the bands are below a depth of 40 inches. In some places the subsoil is continuous loamy sand.

Included with this soil in mapping are small areas of well drained Oshtemo soils. Oshtemo soils and Spinks soils are in similar positions on the landscape. Oshtemo soils are not so droughty as Spinks soils. The included soils make up 2 to 5 percent of the map unit.

Permeability is moderately rapid. The available water capacity is low, and runoff is very slow. The surface layer is friable and is easily tilled within a wide range of moisture content.

This soil is used mainly as cropland. It is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. It is suited to some specialty crops, such as asparagus and gladiolus. Soil blowing and droughtiness are the major concerns in management. Field windbreaks, cover crops, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. Irrigation can increase crop yields if soil moisture levels are low. If this soil is irrigated, water application rates should be regulated to control erosion, and equipment lanes should be seeded.

This soil is well suited to use as woodland. There are few major management concerns. Seedling mortality is moderate. The use of containerized stock may be necessary for higher survival rates.

This soil is well suited to building site development and to use as septic tank absorption fields.

The capability subclass is IIIs. The Michigan soil management group is 4a.

5C—Spinks loamy sand, 6 to 12 percent slopes. This is a gently rolling, well drained soil on side slopes, knolls, and ridges. There are short steep slopes and escarpments adjacent to waterways, lakes, and depressions. The areas are irregular in shape and range from 5 to 600 acres in size.

Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsurface layer is brownish yellow loamy sand about 14 inches thick. The subsoil to a depth of 60 inches is yellowish brown, very friable sand that has bands of dark yellowish brown, very friable loamy sand. In some places the bands are below a depth of 40 inches. In some places the subsoil is loamy sand.

Included with this soil in mapping are small areas of well drained Oshtemo soils and somewhat poorly drained Brady soils. Oshtemo soils and Spinks soils are in similar positions on the landscape. Oshtemo soils are less droughty than Spinks soils. Brady soils are in depressions and drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is low, and runoff is medium. The surface layer is friable and is easily tilled within a wide range of moisture content.

This soil is used mainly as cropland, but many areas are idle grassland or conifer plantations.

This soil is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Soil blowing, water erosion, and droughtiness are major concerns in management. Grassed waterways, field windbreaks, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. Cropping systems that include hay and small grains in the rotation also help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. If soil moisture levels are low, irrigation can increase crop yields. If this soil is irrigated, water application rates should be regulated to control erosion, and equipment lanes should be seeded.

This soil is well suited to use as woodland. There are few major management concerns. Seedling mortality is a moderate limitation. The use of containerized stock may be necessary for higher survival rates.

This soil is suited to building site development and to use as septic tank absorption fields. Slope is the major limitation. Buildings constructed on this soil should be designed to accommodate the slope. Land shaping may be necessary in some areas. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic tank absorption field.

The capability subclass is IIIe. The Michigan soil management group is 4a.

5D—Spinks loamy sand, 12 to 18 percent slopes. This is a rolling, well drained soil on side slopes and ridges. The areas are irregular in shape and range from 5 to 160 acres in size.

Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsoil is about 51 inches thick. The upper part is yellowish brown, very friable loamy sand; the middle part is yellowish brown, loose loamy sand; and the lower part to a depth of about 60 inches is brownish yellow, loose sand that has bands of dark yellowish brown, friable sandy loam. In some places the bands are below a depth of 40 inches. In some places the subsoil is continuous loamy sand.

Included with this soil in mapping are small areas of well drained Oshtemo soils and somewhat poorly drained Brady soils. Oshtemo soils and Spinks soils are in similar positions on the landscape. Oshtemo soils are less droughty than Spinks soils. The Brady soils are in depressions and drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeabiity is moderately rapid. The available water capacity is low, and runoff is medium.

In most areas this soil is idle grassland or is used as woodland.

This soil is suited to crops such as winter wheat and alfalfa hay. Soil blowing, water erosion, and droughtiness are the major concerns in managing the soil. Grassed waterways and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve soil structure, maintain fertility, and increase the available water capacity.

This soil is well suited to use as woodland. There are few major management concerns. Seedling mortality is moderate. The use of containerized stock may be necessary for higher survival rates.

This soil is poorly suited to building site development and to use as septic tank absorption fields. Slope is the major limitation. Buildings constructed on this soil should be designed to accommodate the slope. Land shaping may be necessary in some areas. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic tank absorption field.

The capability subclass is IVe. The Michigan soil management group is 4a.

8A—Nottawa sandy loam, 0 to 3 percent slopes. This is a nearly level, moderately well drained soil in broad, smooth areas on outwash plains. The areas are irregular in shape and range from 240 to 1,900 acres in size.

Typically, the surface layer is very dark brown sandy loam about 11 inches thick. The subsoil is about 35 inches thick. The upper part is dark brown and dark yellowish brown, friable sandy loam; the middle part is dark yellowish brown or yellowish brown, mottled, very friable loamy sand; and the lower part is dark brown, mottled, loose sand. The substratum to a depth of about 60 inches is pale brown, mottled, loose sand. In some places the surface layer is less than 10 inches thick.

Included with this soil in mapping are small areas of well drained Elston soils, somewhat poorly drained Brady soils, and very poorly drained and poorly drained Granby soils. Elston soils are in flat areas that are slightly higher than those areas of the Nottawa soil. Brady soils are in slight depressions. Granby soils are in depressions and drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. The available water capacity is low, and runoff is slow. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The seasonal high water table is at a depth of 2 1/2 to 6 feet from December to March.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Soil blowing and droughtiness are the major concerns in management. Field windbreaks and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. Irrigation can increase crop yields if soil moisture levels are low.

This soil is well suited to building site development, but wetness is a limitation for buildings with basements. Well compacted fill material should be used to raise the site of buildings with basements. Artificial drainage helps lower the water table. This soil is poorly suited to use as septic tank absorption fields because of wetness and poor tiltering capacity. This soil readily absorbs effluent but does not adequately filter it. Poor filtering can result in pollution of the ground water. Special construction, such as filling or mounding the site using suitable material, may be needed to raise the site for sewage disposal above the water table. Sewage lagoons generally are not practical.

The capability subclass is IIs. The Michigan soil management group is 4a.

9A—Elston sandy loam, 0 to 3 percent slopes. This is a nearly level, well drained soil in broad, flat areas on outwash plains. The areas are irregular in shape and range from 200 to 2,000 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsoil is about 38 inches thick.

The upper part is dark brown, friable sandy loam; the middle part is dark brown, very friable loamy sand; and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is pale brown, loose, calcareous sand. In some places the surface layer is less than 10 inches thick.

Included with this soil in mapping are small areas of moderately well drained Nottawa soils, somewhat poorly drained Brady soils, and poorly drained and very poorly drained Granby soils. Nottawa soils are in slightly lower flat areas and in slight depressions. Brady soils are in depressions in the slightly lower flat areas. Granby soils are in depressions and drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. The available water capacity is moderate, and runoff is slow. The surface layer is friable and is easily tilled within a fairly wide range of moisture content.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Soil blowing and droughtiness are the major management concerns. Field windbreaks and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. Irrigation can increase crop yields if soil moisture levels are low.

This soil is well suited to building site development. It is suited to use as septic tank absorption fields, but poor filtering capacity is a limitation. This soil readily absorbs effluent but does not adequately filter it. Poor filtering can result in pollution of the ground water.

The capability subclass is IIs. The Michigan soil management group is 4a.

10B—Hillsdale sandy loam, 2 to 6 percent slopes. This is an undulating, well drained soil on slight knolls, side slopes, and ridges. The areas are irregular in shape and range from 5 to 600 acres in size.

Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is yellowish brown sandy loam about 35 inches thick. The upper part of the subsoil is friable, and the lower part is firm. The substratum to a depth of about 60 inches is yellowish brown, friable sandy loam. In some places the substratum is stratified. In some places there is 20 to 40 inches of sand or loamy sand over the sandy loam subsoil.

Included with this soil in mapping are small areas of moderately well drained Elmdale soils and somewhat poorly drained Teasdale soils. Elmdale soils are in lower flat areas, in slight depressions, and on foot slopes. Teasdale soils are in depressions and along drainageways. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate. The available water capacity is moderate, and runoff is slow or medium. The surface layer is friable and is easily tilled within a fairly wide range of moisture content.

This soil is used mainly as cropland (fig. 6). It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is the major hazard. Winter cover crops, grassed waterways, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help control soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. If this soil is irrigated, the water application rate should be regulated to control water erosion, and equipment lanes should be seeded.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is well suited to building site development and to use as septic tank absorption fields.

The capability subclass is IIe. The Michigan soil management group is 3a.

10C—Hillsdale sandy loam, 6 to 12 percent slopes. This is a gently rolling, well drained soil on side slopes, knolls, and ridges. The areas are irregular in shape and range from 5 to 400 acres in size.

Typically, the surface layer is very dark gray sandy loam about 8 inches thick. The subsoil is about 49 inches thick. The upper part is yellowish brown, friable sandy loam; the middle part is brown, friable sandy clay loam; and the lower part is yellowish brown, friable sandy loam. The substratum to a depth of about 60 inches is yellowish brown, friable sandy loam. In some places the substratum is stratified. In some places there is 20 to 40 inches of sand or loamy sand over the sandy loam subsoil.

Included with this soil in mapping are small areas of well drained Spinks soils, moderately well drained Elmdale soils, and somewhat poorly drained Teasdale soils. Spinks soils are on side slopes and on ridgetops. They are more droughty than Hillsdale soils. Elmdale soils are on foot slopes and in slight depressions. Teasdale soils are in depressions and along drainageways. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate. The available water capacity is moderate, and runoff is medium. The surface layer is friable and is easily tilled within a fairly wide range of moisture content.

In most areas this soil is used as cropland, but there are many areas of woodland. This soil is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is the major hazard. Grassed waterways and conservation tillage that does not invert the soil and

Figure 6.—Hillsdale sandy loam, 2 to 6 percent slopes, is used mainly as cropland. A seep spot is in the foreground.

that leaves all or part of the crop residue on the surface help reduce soil loss. A cropping system that includes hay and small grains also helps reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. If this soil is irrigated, the water application rate needs to be regulated to control erosion, and equipment lanes should be seeded.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is suited to building site development and to use as septic tank absorption fields. Slope is the major limitation. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic tank absorption field.

The capability subclass is IIIe. The Michigan soil management group is 3a.

10D—Hillsdale sandy loam, 12 to 18 percent slopes. This is a rolling, well drained soil on side slopes and ridges. The areas are irregular in shape and range from 20 to 600 acres in size.

Typically, the surface layer is very dark gray sandy loam about 6 inches thick. The subsurface layer is yellowish brown sandy loam about 6 inches thick. The subsoil is yellowish brown and is about 49 inches thick. The upper part of the subsoil is yellowish brown, friable sandy loam; the middle part is dark yellowish brown, friable loam; and the lower part is dark brown, firm sandy loam. The substratum to a depth of 60 inches is yellowish brown, friable sandy loam. In some places the substratum is stratified.

Included with this soil in mapping are small areas of well drained Spinks soils, moderately well drained

Elmdale soils, and somewhat poorly drained Teasdale soils. Spinks soils are on side slopes and on ridgetops. They are more droughty than Hillsdale soils. Elmdale soils are on foot slopes and in slight depressions. Teasdale soils are in depressions and along drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is moderate. Runoff is rapid.

This soil is used mainly as cropland and woodland. It is suited to crops such as corn, winter wheat, and alfalfa hay. Water erosion is the major hazard. Grassed waterways and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help reduce soil loss. A cropping system that includes hay and small grains in the rotation also helps reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity.

This soil is well suited to use as woodland (fig. 7). There are no major management concerns.

This soil is poorly suited to building site development and to use as septic tank absorption fields. Slope is the major limitation. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic tank absorption field.

The capability subclass is IVe. The Michigan soil management group is 3a.

12A—Brady sandy loam, 0 to 2 percent slopes. This is a nearly level, somewhat poorly drained soil in

Figure 7.—Hillsdale sandy loams are well suited to use as woodland.

flat areas and in depressions and drainageways. The areas are irregular in shape and range from 3 to 75 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsoil is mottled and is about 46 inches thick. The upper part is brown, firm sandy loam; the middle part is yellowish brown, friable sandy loam; and the lower part is pale brown or very pale brown, very friable loamy sand. The substratum to a depth of about 60 inches is brown, mottled, loose sand. In some places, the surface layer is more than 9 inches thick.

Included with this soil in mapping are small areas of moderately well drained Bronson soils and very poorly drained and poorly drained Granby soils. Bronson soils are in convex areas that are slightly higher on the landscape than the areas of the Brady soil. Granby soils are in depressions and drainageways. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate. Runoff is very slow. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The seasonal high water table is at a depth of 1 to 3 feet from November to May.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Wetness is the major limitation. Subsurface drainage effectively removes excess water.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is poorly suited to building site development and to use as septic tank absorption fields because of wetness. If the soil is used as a site for buildings, surface or subsurface drains should be used to lower the water table, and well compacted fill material should be used to raise the site. If the soil is used as a septic tank absorption field, special construction, such as filling or mounding the site with suitable soil material, may be needed to raise the sewage disposal area above the water table. This soil is poorly suited to sewage lagoons because of wetness and seepage. Sewage lagoons should be constructed above ground and diked with suitable material. Seepage can be controlled by lining the bottom and sides of the lagoon with impervious material.

The capability subclass is IIw. The Michigan soil management group is 4b.

13—Granby sandy loam. This is a nearly level, poorly drained or very poorly drained soil in broad, flat areas and in depressions and drainageways. This soil is subject to ponding. The areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black sandy loam about 11 inches thick. The subsurface layer is very dark gray, mottled loamy sand about 3 inches thick. The subsoil is dark gray and mottled and is about 14 inches thick. The upper part of the subsoil is friable sandy loam; the lower part is very friable loamy sand. The substratum to a depth of about 60 inches is grayish brown, mottled, loose fine sand or sand. In some places the surface layer is muck. In some places there are thin lenses of organic matter in the subsoil and substratum.

Included with this soil in mapping are small areas of somewhat poorly drained Brady soils and poorly drained or very poorly drained Sebewa soils. Brady soils are in slightly convex areas. Sebewa soils and the Granby soil are in similar positions on the landscape. If the Granby and Sebewa soils are drained, the Sebewa soils are less droughty than the Granby soil. The included soils make up 2 to 15 percent of the map unit.

Permeability is rapid. The available water capacity is low. Runoff is very slow or ponded. The surface layer is very friable and is easily tilled within a fairly wide range of moisture content. The seasonal high water table is near or above the surface from November to June.

This soil is used mainly as cropland. In some small areas it is in wetland vegetation.

If drained, this soil is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Wetness is the major limitation. If drained, this soil is subject to soil blowing. Tile or open ditch drainage effectively removes excess water, but many areas are difficult to drain because adequate outlets are not available. Field windbreaks and winter cover crops help reduce soil blowing.

This soil is poorly suited to use as woodland. Equipment limitations, seedling mortality, and windthrow are the major management concerns. Woodland operations should be limited to seasons of the year when the soil is dry or frozen. Special site preparation, such as bedding, helps to control seedling mortality in some areas. Harvest methods that do not leave trees standing alone or widely spaced help reduce windthrow.

This soil is not suited to building site development or to use as septic tank absorption fields or sewage lagoons because of ponding.

The capability subclass is IVw. The Michigan soil management group is 4c.

14—Sebewa loam. This is a nearly level, poorly drained or very poorly drained soil in broad, flat areas and in depressions and drainageways. This soil is subject to ponding. Individual areas are irregular in shape and range from 3 to 600 acres in size.

Typically, the surface layer is black loam about 13 inches thick. The subsoil is dark gray, mottled, and firm and is about 15 inches thick. The upper part is sandy clay loam, and the lower part is clay loam. The substratum to a depth of about 60 inches is gray, loose sand or grayish brown, loose gravelly sand. In some places the surface layer is muck. In some places there is calcareous gravelly sand below a depth of 18 inches.

Included with this soil in mapping are small areas of somewhat poorly drained Matherton soils and poorly drained or very poorly drained Granby soils. Matherton soils are in the slightly higher positions and the convex areas on the broad flats; they are also on the ridges and side slopes of the drainageways and depressions. Granby soils are in concavities on the broad flats and on the bottoms of the drainageways and depressions. If the Sebewa and Granby soils are drained, the Granby soils are more droughty than the Sebewa soil. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate down to the substratum and rapid in the substratum. The available water capacity is low. Runoff is very slow or ponded. The seasonal high water table is near or above the surface from September to May.

This soil is used mainly as cropland. In some small areas it is used as woodland.

If drained, this soil is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Wetness is the major limitation. Tile or open ditch drainage effectively removes excess water. Surface drains help remove ponded water after heavy rains. Returning crop residue to the soil and regularly adding other organic matter helps improve soil structure, maintain fertility, and increase the available water capacity.

This soil is well suited to use as woodland. Equipment limitations, seedling mortality, and windthrow are the major management concerns. Woodland operations should be limited to seasons of the year when the soil is dry or frozen. Special site preparation, such as bedding, helps control seedling mortality in some areas. Harvest methods that do not leave trees standing alone or widely spaced help reduce windthrow.

This soil is not suited to building site development or to use as septic tank absorption fields or sewage lagoons because of ponding.

The capability subclass is IIw. The Michigan soil management group is 3/5c.

15—Cohoctah loam. This is a nearly level, very poorly drained soil on narrow flood plains. It is flooded frequently and for long periods. There are short steep slopes and escarpments adjacent to uplands. The areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is black loam about 6 inches thick. The substratum is dark gray, mottled, friable loam to a depth of about 30 inches and dark gray, loose gravelly sand to a depth of about 60 inches.

Included with this soil in mapping are small areas of well drained or moderately well drained, loamy or sandy soils on rises and very poorly drained Adrian soils. Adrian soils are moderately deep muck over sand; they are in slightly lower concavities in narrow, flat areas. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. The available water capacity is moderate. Runoff is very slow or ponded. The seasonal high water table is at or above the surface from September to May.

This soil is mainly in wetland vegetation or is used as woodland. In some small areas it is used as pasture.

This soil generally is not suited to cultivated crops. Flooding and wetness are the major concerns in management.

This soil is suited to use as woodland. Equipment limitations, seedling mortality, and windthrow are the major management concerns. Woodland operations should be limited to seasons of the year when the soil is dry or frozen. Special site preparation, such as bedding, helps control seedling mortality in some areas. Harvest methods that do not leave trees standing alone or widely spaced help reduce windthrow.

This soil is not suited to building site development or to use as sewage lagoons or septic tank absorption fields because of flooding.

The capability subclass is Vw. The Michigan soil management group is 2.5/5c.

16B—Elmdale sandy loam, 1 to 6 percent slopes. This is a nearly level to undulating, moderately well drained soil in slightly convex areas and on foot slopes. The areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is friable sandy loam to a depth of about 60 inches. It is brown in the upper part and yellowish brown and mottled in the lower part.

Included with this soil in mapping are small areas of well drained Hillsdale soils and somewhat poorly drained Teasdale soils. Hillsdale soils are on knolls and ridges that are slightly higher on the landscape than the areas of the Elmdale soil. Teasdale soils are in depressions and drainageways. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is moderate, and runoff is moderately slow. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The seasonal high water table is at a depth of 2 to 3 feet from November to April.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is a hazard, and wetness is the major limitation. Conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps reduce soil loss. Random tiling helps remove excess water for early planting. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is suited to building site development, but wetness is a limitation. Surface and subsurface drains help lower the water table. Well compacted fill material should be used to raise the building site. This soil is poorly suited to use as septic tank absorption fields or sewage lagoons because of wetness. If the soil is used as a septic tank absorption field, special construction, such as filling or mounding the site with suitable soil material, may be needed to raise the sewage disposal area above the water table. Sewage lagoons should be constructed above ground and diked using suitable material. The bottom and sides of the lagoon should be lined with impervious material to control seepage.

The capability subclass is IIe. The Michigan soil management group is 3a.

17B—Teasdale sandy loam, 0 to 4 percent slopes. This is a nearly level to undulating, somewhat poorly drained soil in broad, flat areas, on rises, and in depressions and drainageways. The areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is pale brown sandy loam about 7 inches thick. The subsoil is yellowish brown, mottled, and friable; it is about 35 inches thick. The upper part of the subsoil is sandy clay loam or loam; the middle part is sandy loam; and the lower part is loamy sand. The substratum to a depth of about 60 inches is light yellowish brown, mottled, very friable, calcareous loamy sand. In some places the surface layer is darker and thicker than is typical. In some places the substratum is stratified.

Included with this soil in mapping are small areas of moderately well drained Elmdale soils and poorly drained Barry soils. Elmdale soils are in the broad, flat areas and on ridges and side slopes of the depressions and drainageways. Barry soils are in concavities in the broad, flat areas and on the bottoms of the drainageways and depressions. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is moderate. Runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet from November to May.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Wetness is the major limitation. Tile and open ditch drainage effectively remove excess water. Surface drains help remove ponded water after heavy rains. Returning crop residue to the soil and regularly adding other organic matter and conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface help maintain soil structure, improve fertility, and increase the available water capacity.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is poorly suited to building site development and to use as septic tank absorption fields because of wetness. It is poorly suited to sewage lagoons because of wetness and seepage. If this soil is used as a site for buildings, surface or subsurface drains should be used to help lower the water table, and well compacted fill material should be used to raise the level of the site. If the soil is used as a septic tank absorption field, special construction, such as filling or mounding the site with suitable soil material, may be needed to raise the sewage disposal area above the water table. Sewage lagoons should be constructed above ground and diked with suitable material. Lining the bottom and sides of sewage lagoons with impervious material helps control seepage.

The capability subclass is IIw. The Michigan soil management group is 3b.

18—Barry loam. This is a nearly level, poorly drained soil in depressions along drainageways. This soil is subject to ponding. The areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsoil is firm and mottled and is about 19 inches thick. The upper part is dark grayish brown sandy clay loam; the middle part is grayish brown clay loam; and the lower part is gray clay loam. The substratum to a depth of about 60 inches is gray, mottled, friable sandy loam. In some places the surface layer is less than 10 inches thick.

Included with this soil in mapping are small areas of very poorly drained Adrian soils and very poorly drained and poorly drained Granby soils. Adrian soils are moderately deep muck over sand. They are in depressions and drainageways. Granby soils and Barry loam are in similar positions on the landscape, or the Granby soils are in slightly lower positions. If the Barry and Granby soils are drained, the Granby soils are more droughty than Barry soils. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderate. The available water capacity is moderate. Runoff is slow. The seasonal high water table is near or above the surface from November to May.

In most areas this soil is in wetland grasses, or it is wooded. In some small areas it is used as cropland. If drained, this soil is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Wetness is the major limitation. Subsurface drains effectively remove excess water. Surface drains help remove ponded water after heavy rains. Returning crop residue to the soil and regularly adding other organic matter helps improve soil structure.

This soil is suited to use as woodland. Equipment limitations, seedling mortality, and windthrow are the major management concerns. Woodland operations should be limited to seasons of the year when the soil is dry or frozen. Special site preparation, such as bedding, helps control seedling mortality in some areas. Harvest

methods that do not leave trees standing alone or widely spaced help control windthrow.

This soil is not suited to building site development or to use as septic tank absorption fields or sewage lagoons because of ponding.

The capability subclass is IIw. The Michigan soil management group is 3c.

19—Houghton muck. This is a nearly level, very poorly drained soil in broad, flat areas and in depressions and drainageways. It is ponded frequently and for long periods. Short steep slopes and escarpments are adjacent to uplands. The areas are irregular in shape and range from 5 to 400 acres in size.

Typically, the surface tier is black muck about 11 inches thick. Below that, there is black, friable muck about 34 inches thick. The underlying tier to a depth of about 60 inches is dark reddish brown, very friable muck. In some places, a loamy, marly, or sandy substratum is at a depth of less than 51 inches.

Included with this soil in mapping are small areas of very poorly drained Sebewa, Granby, and Cohoctah soils. These are mineral soils, and they are in positions on the landscape similar to those of the Houghton soil. They make up 5 to 15 percent of the map unit.

Permeability is moderately slow to moderately rapid. The available water capacity is high. Runoff is very slow or ponded. The seasonal high water table is near or above the surface from September to June.

In most areas, this soil is in wetland vegetation or brush. If drained, this soil is suited to crops such as corn and soybeans. Wetness is the major limitation. If this soil is drained, soil blowing is a hazard. Tile or open ditch drainage effectively removes excess water. Many areas are difficult to drain, however, because adequate drainage outlets are not available. Field windbreaks and winter cover crops reduce soil blowing.

This soil is poorly suited to use as woodland. Equipment limitations, seedling mortality, and windthrow are the major management concerns. Woodland operations should be limited to seasons of the year when the soil is dry or frozen. Special site preparation, such as bedding, reduces seedling mortality in some areas. Harvest methods that do not leave trees standing alone or widely spaced help reduce windthrow.

This soil is not suited to building site development or to use as septic tank absorption fields or sewage lagoons. Wetness, ponding, and excess humus are the major limitations.

The capability subclass is IIIw. The Michigan soil management group is Mc.

20A—Bronson sandy loam, 0 to 3 percent slopes. This is a nearly level, moderately well drained soil in flat areas, on slight rises, and in depressions. The areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 10 inches thick. The subsoil is yellowish brown, friable sandy loam in the upper part. Below that, dark brown, mottled, friable sandy loam overlies dark brown, mottled, friable loamy sand. The lower part to a depth about 60 inches is dark yellowish brown, mottled, loose sand. In some places there are no gray mottles in the upper 10 inches of the subsoil.

Included with this soil in mapping are small areas of well drained Spinks soils and somewhat poorly drained Brady soils. Spinks soils are in slightly higher flat or convex areas. Brady soils are in slightly lower depressions and drainageways. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. The available water capacity is low. Runoff is slow to medium. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. The seasonal high water table is at a depth of 2 to 3 1/2 feet from November to May.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Soil blowing and droughtiness are the major hazards. Field windbreaks and conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface help reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. Irrigation can increase crop yields if soil moisture levels are low.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is well suited to dwellings without basements, but it is poorly suited to dwellings with basements because of wetness. It is poorly suited to use as septic tank absorption fields because of wetness and poor filtering capacity. Surface or subsurface drainage helps lower the water table. Well compacted fill material should be used to raise building sites. If the soil is used as a septic tank absorption field, filling or mounding the site with suitable soil material or other special construction may be necessary to raise the sewage disposal area above the water table. Sewage lagoons should be constructed above ground and diked with suitable material to control the high water table. Seepage can be reduced by lining the bottom and sides of the lagoon with impervious material.

The capability subclass is IIs. The Michigan soil management group is 4a.

21A—Matherton loam, 0 to 3 percent slopes. This is a nearly level, somewhat poorly drained soil in low flat areas and on slight rises. The areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsurface layer is pale brown, mottled loam about 2 inches thick. The subsoil is mottled and is about 54 inches thick. The upper part is grayish brown or light brownish gray, firm clay loam; the middle part is grayish brown, friable sandy clay loam; and the lower part is yellowish brown, very friable loamy sand. The substratum to a depth of about 70 inches is dark grayish brown, loose, calcareous gravelly sand.

Included with this soil in mapping are small areas of poorly drained Sebewa soils in slight depressions. The included soils make up less than 10 percent of the map unit.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet from November to May.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Wetness is a limitation. Tiles and open ditches effectively remove excess water. Surface drains help remove ponded water after heavy rains.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is poorly suited to building site development because of wetness. It is poorly suited to use as septic tank absorption fields because of wetness and poor filtering capacity, and it is poorly suited to sewage lagoons because of wetness and seepage. If this soil is used as a site for buildings, surface or subsurface drains should be used to lower the water table, and well compacted fill material should be used to raise the site. If the soil is used as a septic tank absorption field, special construction, such as filling or mounding the site with suitable soil material, may be needed to raise the sewage disposal area above the water table. Sewage lagoons on this soil should be lined on the sides and bottom with impervious material to control seepage. Because of the high water table, sewage lagoons may have to be constructed above ground and diked with suitable material.

The capability subclass is IIw. The Michigan soil management group is 3b.

24—Adrian muck. This is a nearly level, very poorly drained soil in broad, flat areas and in depressions and drainageways. It is ponded frequently and for long periods. There are short steep slopes and escarpments adjacent to uplands. The areas are irregular in shape and range from 3 to 640 acres in size.

Typically, the surface tier is black muck about 13 inches thick. The subsurface tier is black, friable muck about 19 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled, loose sand. In some places the organic layer is less than 16 inches thick. In some places there is a layer or pocket of marl in the substratum.

Included with this soil in mapping are small areas of poorly drained Barry soils and very poorly drained Sebewa, Granby, and Cohoctah soils. These are mineral soils that are in positions on the landscape similar to those of Adrian soils. They make up 2 to 15 percent of the map unit.

Permeability is moderately slow to moderately rapid in the organic material and rapid in the underlying layers. The available water capacity is high. Runoff is very slow. The seasonal high water table is near or above the surface from November to May.

Most areas of this soil are idle or are in wetland vegetation. If drained, this soil is suited to crops such as corn and soybeans. It is suited to some specialty crops such as radishes and mint. Wetness is the major limitation. If this soil is drained, soil blowing is a hazard. Tile or open ditch drainage helps remove excess water. Many areas are difficult to drain because suitable drainage outlets are not available. Field windbreaks and winter cover crops help reduce soil blowing.

This soil is poorly suited to use as woodland. Equipment limitations, seedling mortality, and windthrow are the major management concerns. Woodland operations should be limited to seasons of the year when the soil is dry or frozen. Special site preparation, such as bedding, helps control seedling mortality in some areas. Harvest methods that do not leave trees standing alone or widely spaced help prevent windthrow.

This soil is not suited to building site development or to use as septic tank absorption fields or sewage lagoons. Seepage and ponding are the major management concerns.

The capability subclass is IVw. The Michigan soil management group is M/4c.

25—Pits. Pits are open excavations from which the soil and underlying material have been removed. These pits are a source of sand, gravel, and loamy material. Some of the pits contain water. The exposed material supports little or no vegetation. The excavations are 10 to 100 acres in size.

This map unit was not assigned to interpretive groupings.

26—Palms muck. This is a nearly level, very poorly drained soil in depressions and drainageways. It is ponded frequently and for long periods. Short steep slopes and escarpments are adjacent to uplands. The areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface tier is black muck about 10 inches thick. The subsurface tier is black muck about 11 inches thick. The substratum is dark gray silt loam to a depth of 55 inches and dark gray sandy loam to a depth of about 60 inches. In some places the organic layer is

less than 16 inches thick. In some places there is a layer or pocket of marl in the substratum.

Included with this soil in mapping are small areas of very poorly drained Sebewa and Granby soils. These are mineral soils, and they are in positions on the landscape similar to those of Palms soils. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderately slow to moderately rapid in the muck and moderate in the loamy substratum. The available water capacity is high. Runoff is very slow. The seasonal high water table is at or above the surface from November to May.

Most areas of this soil are in wetland vegetation or brush. Wetness is the major limitation to use of this soil as cropland. Most areas are difficult to drain because adequate drainage outlets are not available.

This soil is poorly suited to use as woodland. Equipment limitations, seedling mortality, and windthrow are the major management concerns. Woodland operations should be limited to seasons of the year when the soil is dry or frozen. Special site preparation, such as bedding, helps control seedling mortality. Harvest methods that do not leave trees standing alone or widely spaced minimize the hazard of windthrow.

This soil is not suited to building site development or to use as septic tank absorption fields or sewage lagoons. Excess humus, ponding, and seepage are major management concerns.

The capability subclass is Vw. The Michigan soil management group is M/4c.

27B—Kalamazoo loam, 0 to 6 percent slopes. This is a nearly level to gently sloping, well drained soil in broad, flat areas, in slightly convex areas, and on low ridges. The areas are irregular in shape and range from 3 to 700 acres in size.

Typically, the surface layer is very dark grayish brown loam about 12 inches thick. The subsoil is about 64 inches thick. In the upper part it is dark brown, firm clay loam. Below that, it is dark brown, friable sandy clay loam or sandy loam overlying dark brown, very friable loamy sand. In the lower part it is yellowish brown or dark yellowish brown, very friable loamy sand.

Included with this soil in mapping are small areas of well drained Spinks soils on side slopes. Spinks soils are more droughty than the Kalamazoo soil. They make up less than 10 percent of the map unit.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Runoff is slow to medium.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is a hazard. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface helps reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. If soil moisture levels are low, irrigation can increase crop yields. If this soil is irrigated, the water application rate should be regulated to control erosion, and equipment lanes should be seeded.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is well suited to building site development, but the shrink-swell potential is a moderate limitation. Widening the foundation trench and backfilling it with suitable coarse material reduce the effects of shrinking and swelling. This soil is suited to use as septic tank absorption fields, although its filtering capacity is poor. The soil readily absorbs effluent but does not filter it adequately. Poor filtering can cause pollution of the ground water.

The capability subclass is IIe. The Michigan soil management group is 3a.

27C—Kalamazoo loam, 6 to 12 percent slopes. This is a moderately sloping or gently rolling, well drained soil on knolls and ridges. Individual areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 54 inches thick. The upper part is dark yellowish brown, firm clay loam. Below that, dark brown, friable sandy clay loam or sandy loam overlies dark brown, very friable loamy sand. The lower part of the subsoil is yellowish brown or dark yellowish brown, very friable loamy sand. The substratum to a depth of 84 inches is yellowish brown, loose, calcareous sand.

Included with this soil in mapping are small areas of well drained Spinks soils on side slopes and foot slopes. Spinks soils are more droughty than the Kalamazoo soil. They make up less than 15 percent of the map unit.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate, and runoff is rapid.

This soil is used mainly as cropland. It is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is a hazard. Grassed waterways and conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface help reduce soil loss. A cropping system that includes hay and small grains in the rotation also reduces soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. If the soil moisture level is low, irrigation can increase crop yields. If this soil is irrigated, the water application rate should be regulated to control erosion, and equipment lanes should be seeded.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is suited to building site development, but slope and the shrink-swell potential are moderate

limitations. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessaary in some areas. Widening the foundation trench and backfilling it with suitable coarse material reduce the effects of shrinking and swelling.

This soil is suited to use as septic tank absorption fields, but poor filtering capacity and slope are limitations. This soil readily absorbs effluent but does not filter it adequately. Poor filtering can cause pollution of the ground water. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic tank absorption field.

The capability subclass is IIIe. The Michigan soil management group is 3a.

28B—Riddles sandy loam, 2 to 6 percent slopes. This is a nearly level to undulating, well drained soil in slightly convex areas and on ridges. The areas are irregular in shape and range from 3 to 150 acres in size.

Typically, the surface layer is dark brown sandy loam about 9 inches thick. The subsoil is about 46 inches thick. The upper part is dark brown, firm sandy clay loam; the middle part is yellowish brown, friable sandy loam; and the lower part is dark yellowish brown, friable sandy loam. The substratum to a depth of 60 inches is yellowish brown, very friable loamy sand.

Permeability and the available water capacity are moderate. Runoff is medium.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is the major hazard. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface helps reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is suited to building site development and to use as septic tank absorption fields. The shrink-swell potential is a moderate limitation. Widening the foundation trench and backfilling it with suitable coarse material can reduce the effects of shrinking and swelling.

The capability subclass is IIe. The Michigan soil management group is 2.5a.

28C—Riddles sandy loam, 6 to 18 percent slopes. This is a gently rolling to rolling, well drained soil in convex areas and on knolls and ridges. The areas are irregular in shape and range from 3 to 1,000 acres in size.

Typically, the surface layer is brown, friable sandy loam about 9 inches thick. The subsoil is about 46 inches thick. The upper part is brown, firm clay loam; the middle part is yellowish brown, friable sandy clay loam; and the lower part is yellowish brown or dark yellowish brown, friable sandy loam. The substratum to a depth of about 60 inches is dark yellowish brown, very friable loamy sand.

Included with this soil in mapping are small areas of well drained Spinks soils on side slopes and foot slopes. Spinks soils are more droughty than Riddles soils. They make up less than 10 percent of the map unit.

Permeability and the available water capacity are moderate. Runoff is rapid.

This soil is used mainly as cropland or woodland. It is suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is a hazard. Grassed waterways and conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface help reduce soil loss. A cropping system that includes hay and small grains in the rotation also helps reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity.

This soil is well suited to use as woodland. There are no major management concerns.

This soil is suited to building site development, but slope and the shrink-swell potential are moderate limitations. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Widening the foundation trench and backfilling it with suitable coarse material can reduce the effects of shrinking and swelling. This soil is suited to use as septic tank absorption fields, but slope is a limitation. Land shaping and installing the distribution lines across the slope generally are necessary for the proper operation of a septic field.

The capability subclass is IVe. The Michigan soil management group is 2.5a.

29B—Schoolcraft loam, 0 to 4 percent slopes. This is a nearly level to gently sloping, well drained soil in broad, flat areas and on side slopes. The areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface layer is dark brown loam about 11 inches thick. The subsoil is about 20 inches thick. The upper part is dark yellowish brown, firm clay loam; the middle part is dark brown, friable sandy clay loam; and the lower part is dark yellowish brown, very friable sandy loam. The substratum is yellowish brown, very friable loamy sand in the upper 39 inches and pale brown, loose, calcareous gravelly sand to a depth of about 75 inches.

Included with this soil in mapping are small areas of somewhat poorly drained Brady soils in slight depressions. Brady soils, if drained, are more droughty than Schoolcraft soils. They make up less than 5 percent of the map unit.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate, and runoff is slow or medium.

This soil is used mainly as cropland. It is well suited to crops such as corn, soybeans, winter wheat, and alfalfa hay. Water erosion is a hazard. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface helps reduce soil loss. Returning crop residue to the soil and regularly adding other organic matter helps improve fertility, maintain soil structure, and increase the available water capacity. If the soil moisture level is low, irrigation can help increase crop yields. If this soil is irrigated, the water application rate should be regulated to control erosion, and equipment lanes should be seeded.

This soil is well suited to building site development. It is suited to use as septic tank absorption fields, but its filtering capacity is poor. This soil readily absorbs effluent but does not filter it adequately. Poor filtering can cause pollution of the ground water.

The capability subclass is IIe. The Michigan soil management group is 2.5a.

30B—Urban land-Oshtemo complex, 0 to 6 percent slopes. This complex consists of Urban land and nearly level or gently sloping, well drained Oshtemo soil in broad, flat areas and on side slopes. The areas of Urban land and of Oshtemo soil are so small or so intricately mixed that it was not practical to separate them in mapping. The mapped areas range from 50 to 1,000 acres in size and consist of 50 to 85 percent Urban land and 10 to 45 percent Oshtemo soil.

Urban land consists of areas that are covered by streets, parking lots, and buildings and other structures.

Typically, the Oshtemo soil has a surface layer of dark grayish brown sandy loam about 9 inches thick. The subsurface layer is brown sandy loam about 5 inches thick. The subsoil is about 46 inches thick. The upper part is dark reddish brown, friable sandy loam, and the lower part is dark brown, loose loamy sand. The substratum to a depth of about 66 inches is grayish brown, loose, calcareous gravelly sand. In some places calcareous sand or gravelly sand is at a depth of less than 40 inches.

Included with this complex in mapping are small areas of well drained Spinks soils and somewhat poorly drained Brady soils. Spinks soils and the Oshtemo soil are in similar positions on the landscape. Spinks soils are more droughty than the Oshtemo soil. Brady soils are in depressions. Also included are some fill areas along rivers and streams. The included soils make up less than 5 percent of the complex.

Permeability of the Oshtemo soil is moderately rapid. The available water capacity is moderate. Runoff is slow or medium.

The Oshtemo soil is used for parks, lawns, gardens, and other open space and as a site for buildings. It is well suited to lawns, gardens, ornamental trees, and shrubs. Perennial plants that can withstand dry conditions in summer should be selected. Droughtiness is a hazard. Regular additions of water during dry periods can eliminate this hazard. Adding organic matter in the form of peat or topsoil to the soil can help increase its available water capacity.

The Oshtemo soil is well suited to building site development. Sanitary facilities should be connected to commercial sewers and treatment facilities.

This complex was not assigned to interpretive groupings.

31B—Udorthents, loamy. This map unit consists of soils that have been dredged from rivers, swamps, or ponds or removed during land shaping at construction sites. The soils are cover for landfills or are put into piles adjacent to the dredged areas. The soil material is somewhat excessively drained to somewhat poorly drained. The areas are not extensive and range from 3 to 10 acres in size.

These soils have limited suitability as a source of topsoil or as a source of fill material for construction.

This map unit was not assigned to interpretive groupings.

32—Dumps. The map unit conists of nonsoil material, such as tree stumps, construction debris, old automobile parts, and household appliances, that is used as fill material in swamps, flood plains, and other depressions. The areas are not extensive and range from 3 to 40 acres in size.

The areas generally are not suited to use as cropland, woodland, construction sites, or recreation sites.

This map unit was not assigned to interpretive groupings.

33A—Urban land-Elston complex, 0 to 3 percent slopes. This complex consists of Urban land and nearly level, well drained Elston soil in broad, flat areas. The areas of Urban land and of Elston soil are so small or so intricately mixed that it was not practical to separate them in mapping. The mapped areas range from 300 to 800 acres in size and consist of 50 to 85 percent Urban land and 10 to 45 percent Elston soil.

Urban land consists of areas that are covered by streets, parking lots, and buildings and other structures.

Typically, the Elston soil has a surface layer of black sandy loam about 10 inches thick. The subsoil is about 39 inches thick. The upper part is dark brown, friable sandy loam; the middle part is dark brown, very friable loamy sand; and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is pale brown, loose, calcareous sand.

Included with this complex in mapping are small areas of somewhat poorly drained Brady soils and very poorly drained Cohoctah soils. Brady soils are in depressions. Cohoctah soils are on flood plains adjacent to waterways. Also included are some fill areas along rivers

and streams. The included soils make up less than 5 percent of the complex.

Permeability of the Elston soil is moderately rapid. The available water capacity is moderate, and runoff is slow or medium.

The Elston soil is used for parks, lawns, gardens, and other open space and as a site for buildings. It is well suited to lawns and gardens and is a good source of topsoil. This soil is well suited to ornamental trees and shrubs.

The Elston soil is well suited to building site development. All sanitary facilities should be connected to commercial sewers and treatment facilities.

This complex was not assigned to interpretive groupings.

prime farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in St. Joseph County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

Soils that have a high water table may qualify as prime farmland soils if the limitation is overcome by drainage. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

A recent trend in land use has been the conversion of prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in St. Joseph County. On some soils included in the list, appropriate measures have been applied to overcome wetness. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed soil map units." This list does not constitute a recommendation for a particular land use.

4B	Oshtemo sandy loam, 0 to 6 percent slopes
8A	Nottawa sandy loam, 0 to 3 percent slopes
9A	Elston sandy loam, 0 to 3 percent slopes
10B	Hillsdale sandy loam, 2 to 6 percent slopes
12A	Brady sandy loam, 0 to 2 percent slopes (where drained)
14	Sebewa loam (where drained)
16B	Elmdale sandy loam, 1 to 6 percent slopes
17B	Teasdale sandy loam, 0 to 4 percent slopes (where drained)
18	Barry loam (where drained)
20A	Bronson sandy loam, 0 to 3 percent slopes
21A	Matherton loam, 0 to 3 percent slopes (where drained)
27B	Kalamazoo loam, 0 to 6 percent slopes
28B	Riddles sandy loam, 2 to 6 percent slopes
29B	Schoolcraft loam, 0 to 4 percent slopes

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where wetness or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

Dwight L. Quisenberry, agronomist, and Allan G. Herceg, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1968, according to the Michigan Conservation Needs Inventory of that year, more than 222,000 acres in the county were used for crops and pasture. In 1977, according to the Agricultural Stabilization and Conservation Service and the Cooperative Extension Service, 95,400 acres were used for corn, 21,000 acres for soybeans, and 23,200 acres for small grains. The rest of the acreage was mainly in hay and pasture.

Field crops commonly grown in the county are corn, soybeans, and, to a limited extent, sorghum. Wheat and oats are the most common small grains; there are small acreages of rye and barley. Alfalfa hay is a cash crop; more is sold than is used for livestock.

Specialty crops, except for seed corn, are of limited commercial importance in the county. There are small acreages of sunflowers, flower bulbs, cucumbers, strawberries, radishes, mint, and asparagus and a small number of tree farms, fruit farms, and nurseries.

Seed corn production, on the other hand, is of major importance in St. Joseph County. Approximately 16,000 acres are used for production of seed corn. The growing importance of this crop is due mainly to the increased use of irrigation. Control of the moisture level in the soil through irrigation results in high levels of production.

The crop yield in St. Joseph County is one of the highest in Michigan. More than 90 percent of the total land area is in farms, and many of the farmland soils have a capability classification of II, which means that the soils have only moderate limitations. Soil and water conservation practices, irrigation, and the latest crop production technology are increasing the productivity of all the cropland in the county.

In St. Joseph County, the average size of farms has increased, and farm operations are becoming highly mechanized and scientific. Nevertheless, some soil related problems remain.

Soil blowing is a hazard on Spinks loamy sands, on Oshtemo, Nottawa, and Elston sandy loams, and on Houghton muck. Crop damage and soil loss can be

severe in fields that have little vegetative cover if the wind is strong and the soil is dry. A conservation tillage system that leaves crop residue on the surface minimizes soil blowing on these soils. Field windbreaks also can effectively reduce soil blowing. On fields where a center pivot irrigation system is used, low-growing shrubs can be planted as a windbreak.

Erosion is a major hazard on some of the loamy soils that have slopes of more than 3 percent; for example, Hillsdale, Kalamazoo, and Riddles soils. The loss of the surface layer through erosion results in reduced productivity, and it can cause sedimentation of streams. As the surface layer erodes, nutrients and organic matter are lost, and part of the subsoil is incorporated into the plow layer. The subsoil, which is dominantly loamy sand or sandy loam and is gravelly, has a lower available moisture capacity, fewer nutrients, and less organic matter than the surface layer. Consequently, eroded soils tend to be droughty, and their fertility and tilth are reduced.

Controlling erosion reduces the amount of sediment that gets into streams, adding to the pollution of water supplies.

Controlling erosion reduces runoff and increases water infiltration. A cropping system that keeps a vegetative cover on the soil for extended periods can hold soil losses to a level that does not reduce the productivity of the soil. On livestock farms, where hay and pasture are needed, legume and grass forage crops in the sloping areas reduce erosion, increase the nitrogen level, and improve soil tilth.

Slopes in St. Joseph county are so short and irregular that contour tillage is not practical in most areas. Conservation tillage or a cropping system that provides substantial vegetative cover should be used to control erosion. No-tillage for corn and soybeans reduces erosion on gently sloping to moderately sloping soils.

The use of grassed waterways effectively reduces erosion. Permanent vegetative cover should be maintained where surface runoff concentrates.

Information on the control of erosion and soil blowing is available at local offices of the Soil Conservation Service.

Soil drainage is necessary on some of the soils in the county that are used for crops and pasture. Some soils are naturally so wet that, unless they are drained, production of crops common to the area is not possible. The poorly drained or very poorly drained soils in the county are the Barry, Granby, and Sebewa soils. The Adrian, Houghton, and Palms soils are very poorly drained organic soils.

Unless artificially drained, the somewhat poorly drained soils are so wet that crop yields are reduced in most years. Brady, Teasdale, and Matherton soils are somewhat poorly drained. Bronson, Elmdale, and Nottawa soils are moderately well drained. Natural drainge is adequate most of the year; however, artificial drainage is needed in some small areas along drainageways and swales. Frequently, moderately well drained hillside seeps on the moderately well drained soils and the well drained Hillsdale soils need random tiling.

In most areas of the somewhat poorly drained, poorly drained, and very poorly drained soils, a combination of surface drainage and tile drainage is needed if the soils are used for intensive row cropping. Random tile drainage generally is adequate for the moderately well drained soils. Finding adequate outlets for a tile drainage system is difficult in many areas of Houghton, Adrian, Palms, Barry, Sebewa, Granby, and Cohoctah soils.

Irrigation makes cultivation practical on droughty soils (fig. 8). In the past 10 years, the number of irrigated acres in St. Joseph County has increased to nearly 57,000, or approximately 50 percent of the land area used for row crops.

St. Joseph County is well known as one of the driest counties east of the Mississippi River. The major soils in the county—Spinks, Oshtemo, Nottawa, and Elston soils— have a low or moderate available water capacity. Drought frequently can reduce crop yields on these soils.

Manmade ponds, surface water, shallow wells, and soils that have a good intake rate make irrigation feasible (fig. 9). Increased crop yields from irrigation and changes in irrigation equipment have resulted in the use of irrigation for row crops on soils that have slopes of more than 12 percent. Conservation tillage, grassed waterways, and irrigation water management are needed to control runoff, reduce soil erosion, and improve the efficiency of the irrigation system.

Soil fertility is naturally low in the sandy soils in the county and medium in most of the loamy soils. Most of the soils are strongly acid to neutral. Some of the most acid soils have manganese, boron, or zinc deficiencies.

Applications of lime and fertilizer on all soils should be based on the results of soil tests, the need of the crop, and the expected yield. The Cooperative Extension Service can help determine the kind and amount of fertilizer and lime to apply.

Soil tilth is important for the germination of seeds and for the infiltration of water into the soil. Soils that have good tilth are granular and porous.

Many of the soils in St. Joseph County that are used for crops have a sandy loam surface layer. Generally the structure of such soils is weak. If the soil is wet, plowing, cultivating, and other operations that involve heavy machinery cause soil compaction and surface crusting. Surface crust reduces infiltration and increases runoff. Excessive tillage breaks the soil down into very small, less stable aggregates. Such small particles tend to form crusts, and they blow or wash away more readily than larger particles.

Adequate surface and subsurface drainage, timely field

Figure 8.—Irrigation can increase crop yields on Oshtemo, Spinks, and other soils that have a low or moderate available water capacity.

operations on relatively dry soil, conservation tillage, and maintaining the level of organic matter in the soil help improve soil structure, reduce soil compaction, and prevent the formation of crusts.

Pasture is becoming less and less extensive in the county, and the number of livestock operations continues to decline.

The wet soils most frequently are used for pasture. In St. Joseph County, these are the Brady, Granby, Sebewa, Barry, Cohoctah, and Matherton soils. Well drained soils that have steep slopes also are used for pasture; for example, the Spinks, Oshtemo, Hillsdale, and Riddles soils. Grazing should be deferred on wet soils early in spring and late in fall. Management to prevent overgrazing, which depletes the protective vegetative cover, is needed in rolling areas that are used for pasture.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties;

Figure 9.—An irrigation pond in an area of Adrian muck.

appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only

class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability subclass and the Michigan soil management group for each detailed map unit are given at the end of the map unit descriptions in the section "Detailed soil map units." The soil management groups are based on the need of the soils for lime and fertilizer and for artificial drainage and other practices. For an explanation of these groups, refer to the Michigan State University report "Soil Management Units and Land Use Planning" (*3*).

woodland management and productivity

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and

strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, keep snow from blowing off the fields, and provide food and cover for wildlife (fig. 10).

Environmental plantings help to beautify and screen

Figure 10.—Low-growing shrubs are used as a windbreak in fields that use a center-pivot irrigation system. The soil is Spinks loamy sand.

houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management,

and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, soybeans, and sunflowers.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, timothy, birdsfoot trefoil, sudangrass, crownvetch, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are goldenrod, beggarweed, milkweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, beech, apple, hawthorn, dogwood, hickory, blackberry, serviceberry, and grapes. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are honeysuckle, American cranberrybush, autumn-olive, crabapple, silver buffaloberry, and wild grape.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, and slope. Examples of wetland plants are smartweed, wild millet, arrowhead, cattails, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, woodchuck, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, owls, thrushes, woodpeckers, tree squirrels, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, kingfishers, shore birds, muskrat, and beaver.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils

may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by stone content, soil texture, and slope. The time of the year that excavations can be made is affected by depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, and flooding affect absorption of the effluent. Large stones interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, and rock fragments.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and

special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table and permeability of the aquifer. The content of large stones affects the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on permeability, depth to a high water table or depth of standing water if the soil is subject to ponding, slope, susceptibility to flooding, subsidence of organic layers, and potential frost action. Excavating and grading and the stability of ditchbanks are affected by large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones. The performance of a system is affected by the depth of the root zone and soil reaction.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, and slope affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 or 20 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 17 shows total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or*high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture and acidity.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*9*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 18, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is sandy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*8*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*9*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Adrian series

The Adrian series consists of very poorly drained soils in bogs or depressions on outwash plains, till plains, or lake plains. Adrian soils formed in organic deposits 16 to 50 inches thick over sandy deposits. Permeability is moderately slow to moderately rapid in the organic material and rapid in the underlying layers. The slopes are less than 1 percent.

Adrian soils are similar to Palms soils and are commonly adjacent to Cohoctah, Granby, Houghton, and Sebewa soils. Palms soils formed in organic deposits 16 to 50 inches thick over loamy deposits. Cohoctah soils

are on flood plains. They have mineral horizons in which the organic matter content decreases irregularly as the depth increases. Granby soils do not have organic horizons and are in similar or slightly higher positions on the landscape. Houghton soils have organic matter to a depth of more than 51 inches. Sebewa soils have fine loamy material over sandy or sandy skeletal deposits. Houghton and Sebewa soils are in positions on the landscape similar to those of the Adrian soils.

Typical pedon of Adrian muck, 200 feet west and 200 feet south of the northeast corner of sec. 26, T. 7 S., R. 11 W.

Oa1—0 to 13 inches; black (N 2/0) broken face or rubbed sapric material; moderate medium granular structure; friable; medium acid; clear smooth boundary.

Oa2—13 to 24 inches; black (5YR 2/1) broken face or rubbed sapric material; about 5 percent fiber, trace rubbed; weak coarse subangular blocky structure; friable; slightly acid; gradual wavy boundary.

Oa3—24 to 32 inches; black (5YR 2/1) broken face or rubbed sapric material; about 20 percent fiber, trace rubbed; weak thick platy structure; friable; slightly acid; clear wavy boundary.

IICg—32 to 60 inches; dark gray (10YR 4/1) sand; common medium distinct strong brown (7.5YR 5/8) mottles; single grain; neutral.

The depth to the sandy IICg horizon ranges from 16 to 50 inches. Reaction of the organic part ranges from medium acid to neutral.

The surface tier has hue of 7.5YR or 10YR, or it is neutral, and it has chroma of 0 or 1. The organic part of the subsurface and bottom tiers has hue of 5YR, 7.5YR, or 10YR; value of 2 or 3; and chroma of 0 to 3. The organic part of the subsurface and bottom tiers is primarily sapric material; however, in some places, there are thin layers of hemic material that have a combined thickness of less than 10 inches. The IICg horizon has value of 4 or 5 and chroma of 1 or 2. It is sand, loamy sand, gravelly sand, or gravelly loamy sand and ranges from neutral to moderately alkaline.

Barry series

The Barry series consists of poorly drained, moderately permeable soils on till plains and moraines. Barry soils formed in loamy deposits. The slopes range from 0 to 2 percent.

Barry soils are commonly adjacent to Elmdale and Teasdale soils. Elmdale soils are moderately well drained; they are coarser textured than Barry soils. Teasdale soils are somewhat poorly drained, and they also are coarser textured. Elmdale and Teasdale soils are in slightly higher positions on the landscape than those of the Barry soils.

Typical pedon of Barry loam, 2,245 feet west and 260 feet north of the southeast corner of sec. 2, T. 5 S., R. 9 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; few fine faint dark grayish brown (10YR 4/2) and few fine distinct dark brown (7.5YR 4/4) mottles; weak medium granular structure; friable; 5 percent pebbles; neutral; clear wavy boundary.

B21tg—10 to 15 inches; dark grayish brown (10YR 4/2) sandy clay loam; common medium faint very dark gray (10YR 3/1) and common fine distinct strong brown (7.5YR 5/6) mottles; moderate very thick platy structure parting to moderate medium subangular blocky; firm; thick continuous clay films on faces of peds; 10 percent pebbles and cobbles; neutral; gradual wavy boundary.

B22tg—15 to 21 inches; grayish brown (10YR 5/2) clay loam; common medium distinct yellowish red (5YR 5/6) and few medium distinct yellowish red (5YR 4/6) mottles; strong medium subangular blocky structure; firm; thin continuous clay films on faces of peds; 10 percent pebbles and cobbles; neutral; gradual wavy boundary.

B23tg—21 to 29 inches; gray (10YR 5/1) clay loam; common fine distinct yellowish red (5YR 5/6) and common medium distinct reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; firm; thin continuous clay films on faces of peds; 10 percent pebbles and cobbles; neutral; clear smooth boundary.

Cg—29 to 60 inches; gray (10YR 5/1) sandy loam; common fine distinct yellowish red (5YR 4/6 and 5YR 5/6) mottles; massive; friable; 15 percent pebbles and cobbles; neutral.

The solum ranges from 24 to 50 inches in thickness. It is slightly acid to mildly alkaline. The Ap or A1 horizon ranges from 10 to 15 inches in thickness. The pebble and cobble content ranges from 1 to 15 percent throughout.

The Ap or A1 horizon has value of 2 or 3. It is dominantly loam, but the range includes sandy loam. The B2tg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy clay loam, clay loam, loam, or sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. It is sandy loam or loamy sand and is neutral or mildly alkaline.

Brady series

The Brady series consists of somewhat poorly drained, moderately rapidly permeable soils on outwash plains and lake plains. Brady soils formed in loamy and sandy deposits over sand. The slopes range from 0 to 2 percent.

Brady soils are similar to Bronson soils and are commonly adjacent to Oshtemo and Spinks soils. Bronson soils are moderately well drained. They are in slightly higher positions on the landscape than those of the Brady soils. Oshtemo and Spinks soils are well drained. They are in higher positions on the landscape than those of the Brady soils.

Typical pedon of Brady sandy loam, 0 to 2 percent slopes, 2,500 feet east and 600 feet south of the northwest corner of sec. 9, T. 6 S., R. 10 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 5/3) dry; moderate medium granular structure; friable; 1 percent pebbles; neutral; abrupt smooth boundary.

B21t—9 to 15 inches; brown (10YR 5/3) sandy loam; common medium distinct yellowish brown (10YR 5/6) and few medium distinct grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; firm; 1 percent pebbles; thin continuous clay films on faces of peds; strongly acid; clear wavy boundary.

B22t—15 to 21 inches; yellowish brown (10YR 5/4) sandy loam; few fine distinct grayish brown (10YR 5/2), common fine distinct brownish yellow (10YR 6/6), and common medium distinct yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; friable; 1 percent pebbles; thin continuous clay films on faces of peds; strongly acid; clear wavy boundary.

B23t—21 to 24 inches; yellowish brown (10YR 5/4) sandy loam; few fine faint grayish brown (10YR 5/2) and many medium distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; 1 percent pebbles; thin discontinuous clay films on faces of peds; strongly acid; clear wavy boundary.

IIB31t—24 to 31 inches; pale brown (10YR 6/3) loamy sand; many medium distinct strong brown (7.5YR 5/8) mottles; weak fine subangular blocky structure; very friable; 1 percent pebbles; clay bridging of sand grains; strongly acid; gradual wavy boundary.

IIB32t—31 to 55 inches; very pale brown (10YR 7/3) loamy sand; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; 1 percent pebbles; strongly acid; clear wavy boundary.

IIC—55 to 60 inches; brown (10YR 5/3) sand; common medium distinct light gray (10YR 7/2) mottles; single grain; loose; 1 percent pebbles; medium acid.

The solum ranges from 40 to 70 inches in thickness but is typically 48 to 60 inches thick. It is neutral to strongly acid. The pebble and cobble content ranges from 1 to 20 percent throughout.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly sandy loam, but the range includes loamy sand. The B2t horizon has value of 4 to 6 and chroma of 3 or 4. It is sandy loam, gravelly sandy loam, or gravelly sandy clay loam. The IIB horizon has value of 6 or 7. It is loamy sand or sandy loam. In some places there is no IIB horizon. The IIC horizon has chroma of 2 or 3. It is sand, gravelly sand, or stratified sand and gravel.

Bronson series

The Bronson series consists of moderately well drained soils on outwash plains. Bronson soils formed in loamy and sandy sediments. Permeability is moderately rapid in the upper part of the solum and rapid in the lower part. The slopes range from 0 to 3 percent.

Bronson soils are similar to Brady and Oshtemo soils and are commonly adjacent to Oshtemo and Spinks soils. Brady soils are somewhat poorly drained. Oshtemo soils are well drained. Spinks soils are well drained. Unlike Bronson soils, they do not have a continuous argillic horizon, and they are in slightly higher positions on the landscape.

Typical pedon of Bronson sandy loam, 0 to 3 percent slopes, 2,100 feet north and 400 feet west of the southeast corner of sec. 22, T. 5 S., R. 9 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; weak medium granular structure; friable; 5 percent pebbles; slightly acid; abrupt smooth boundary.

B21t—10 to 15 inches; yellowish brown (10YR 5/4) sandy loam; weak medium subangular structure; friable; thin discontinuous clay films on faces of peds; 5 percent pebbles; medium acid; gradual wavy boundary.

B22t—15 to 26 inches; dark brown (10YR 4/3) sandy loam; few fine faint gray (10YR 5/1) and few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; thin discontinuous clay films on faces of peds; 5 percent pebbles; medium acid; gradual wavy boundary.

B23t—26 to 34 inches; dark brown (7.5YR 4/4) loamy sand; few fine faint strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; clay bridging of sand grains; 5 percent pebbles; medium acid; clear wavy boundary.

B3—34 to 60 inches; dark yellowish brown (10YR 4/6) sand; few fine faint strong brown (7.5YR 5/6) mottles; single grain; loose; 5 percent pebbles; medium acid.

The thickness of the solum and the depth to free carbonates range from 40 to 70 inches. The solum ranges from neutral to strongly acid. The pebble content ranges from 0 to 20 percent throughout.

The Ap horizon has value of 3 to 5 and chroma of 2 to 4. It is dominantly sandy loam, but the range includes loamy sand. The B horizon has hue of 10YR or 7.5YR,

value of 3 to 5, and chroma of 3 to 6. It is sandy loam or loamy sand. In some places there is a IIC horizon that has value of 4 or 5 and chroma of 2 or 3. It is sand, gravelly sand, or stratified sand and gravel and ranges from slightly acid to moderately alkaline.

Cohoctah series

The Cohoctah series consists of very poorly drained, moderately rapidly permeable over very rapidly permeable soils on flood plains. Cohoctah soils formed in loamy deposits over gravelly sandy deposits. The slopes range from 0 to 1 percent.

The surface layer of these soils is slightly thinner and the depth to gravelly sand is less than that defined for the series. These differences, however, do not affect the use or behavior of these soils.

Cohoctah soils are commonly adjacent to Adrian, Granby, and Houghton soils. Adrian soils have 16 to 50 inches of organic matter over sandy deposits and are in similar or slightly lower positions on the landscape. Granby soils have a coarser textured Bg horizon, do not have pockets or layers of organic matter in the Cg horizon, and are in slightly higher positions on the landscape. Houghton soils formed in organic deposits more than 51 inches thick and are in similar or slightly lower positions on the landscape.

Typical pedon of Cohoctah loam, 2,229 feet south and 100 feet east of the northwest corner of sec. 11, T. 8 S., R. 12 W.

A1—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine granular structure; friable; mildly alkaline; clear wavy boundary.

C1g—6 to 30 inches; dark gray (10YR 4/1) loam; many fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; mildly alkaline; clear wavy boundary.

IIC2g—30 to 60 inches; dark gray (10YR 4/1) gravelly sand; single grain; loose; strong effervescence; moderately alkaline.

The soil is neutral to mildly alkaline in the upper 30 inches and moderately alkaline in the lower 30 inches.

The A1 horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam, fine sandy loam, and loamy sand. The Cg horizon has value of 3 to 5 and chroma of 1 or 2. It is loam, sandy loam, or loamy sand that has gravelly sand below a depth of 30 inches. There are thin layers or pockets of organic material in the Cg horizon.

Elmdale series

The Elmdale series consists of moderately well drained, moderately permeable soils on till plains and moraines. Elmdale soils formed in loamy deposits. The slopes range from 1 to 6 percent.

Elmdale soils are similar to Hillsdale and Teasdale soils and are commonly adjacent to Barry soils. Barry soils are poorly drained. They are finer textured than Elmdale soils. They are in depressions and drainageways. Hillsdale soils are well drained. They are in slightly higher positions on the landscape than those of the Elmdale soils. Teasdale soils are somewhat poorly drained.

Typical pedon of Elmdale sandy loam, 1 to 6 percent slopes, 50 feet south and 360 feet west of the northeast corner of sec. 15, T. 5 S., R. 10 W.

Ap—0 to 10 inches; dark brown (10YR 3/3) sandy loam, pale brown (10YR 6/3) dry; moderate medium granular structure; friable; 1 percent pebbles; strongly acid; abrupt wavy boundary.

B21t—10 to 23 inches; brown (10YR 5/3) sandy loam; moderate fine subangular blocky structure; friable; thin discontinuous clay films; 1 percent pebbles; strongly acid; gradual wavy boundary.

B22t—23 to 27 inches; brown (10YR 5/3) sandy loam; few fine distinct yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; friable; thin discontinuous dark yellowish brown (10YR 4/4) clay films; 1 percent pebbles; very strongly acid; clear wavy boundary.

B23t—27 to 34 inches; yellowish brown (10YR 5/4) sandy loam; common fine faint yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; friable; thin continuous dark yellowish brown (10YR 4/4) clay films; 3 percent pebbles; very strongly acid; gradual wavy boundary.

B24t—34 to 47 inches; yellowish brown (10YR 5/4) sandy loam; few fine faint yellowish brown (10YR 5/8) mottles; moderate fine subangular blocky structure; friable; thin discontinuous dark yellowish brown (10YR 4/4) clay films; 3 percent pebbles; strongly acid; clear wavy boundary.

B3—47 to 60 inches; yellowish brown (10YR 5/4) sandy loam; common fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; 5 percent pebbles; strongly acid.

The solum ranges from 40 to more than 60 inches in thickness. It is slightly acid to very strongly acid. The pebble and cobble content ranges from 0 to 15 percent throughout.

The Ap horizon has value of 3 to 5 and chroma of 2 or 3. Some pedons have an A1 horizon that has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Some pedons have an A2 horizon. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam, loam, or sandy clay loam. The B3 horizon has value of 4 to 6 and chroma of 3 or 4. It is dominantly sandy loam and has strata of loamy sand in some

places. In some places there is a C horizon. It has hue of 10YR, value of 4 to 6, and chroma of 3 or 4. It is sandy loam or loamy sand and ranges from neutral to moderately alkaline.

Elston series

The Elston series consists of well drained soils on outwash plains. Elston soils formed in loamy and sandy sediments. Permeability is moderately rapid in the upper part of the solum and rapid in the lower part. The slopes range from 0 to 3 percent.

Elston soils are similar to Nottawa and Oshtemo soils and are commonly adjacent to Oshtemo and Spinks soils. Nottawa soils are moderately well drained. Oshtemo soils do not have a mollic epipedon. Spinks soils do not have a mollic epipedon or a continuous argillic horizon. Oshtemo and Spinks soils are in similar or higher positions on the landscape.

Typical pedon of Elston sandy loam, 0 to 3 percent slopes, 1,320 feet north and 200 feet east of the southwest corner of sec. 30, T. 7 S., R. 11 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; friable; 5 percent pebbles; slightly acid; abrupt smooth boundary.

B21t—10 to 28 inches; dark brown (10YR 3/3) sandy loam; weak medium granular structure; friable; thick continuous clay films on faces of peds; 15 percent pebbles and cobbles; medium acid; clear wavy boundary.

B22t—28 to 39 inches; dark brown (7.5YR 4/4) loamy sand; weak very fine subangular blocky structure; very friable; thin discontinuous clay films on faces of peds; 10 percent pebbles and cobbles; strongly acid; clear wavy boundary.

B3t—39 to 48 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; clay bridging of sand grains; 5 percent pebbles; strongly acid; clear wavy boundary.

C—48 to 60 inches; pale brown (10YR 6/3) sand; single grain; loose; 5 percent pebbles; strong effervescence; moderately alkaline.

The solum ranges from 42 to 72 inches in thickness. It is neutral to strongly acid. The pebble and cobble content ranges from 0 to 20 percent throughout.

The Ap horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly sandy loam, but the range includes loam. The B2 horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5; and chroma of 3 or 4. It is typically sandy loam or loam that has individual horizons of sandy clay loam or loamy sand. The C horizon ranges from medium acid to moderately alkaline.

Granby series

The Granby series consists of poorly drained or very poorly drained, rapidly permeable soils on outwash plains and lake plains. Granby soils formed in sandy and loamy sediments. The slopes range from 0 to 2 percent.

Granby soils are commonly adjacent to Adrian, Cohoctah, and Sebewa soils. Adrian soils have 16 to 50 inches of organic matter over sandy deposits and are in similar or slightly lower positions on the landscape. Cohoctah soils have layers and pockets of organic matter in the Cg horizon and are on flood plains. Sebewa soils are finer textured than Granby soils. They are in similar positions on the landscape.

Typical pedon of Granby sandy loam, 725 feet south and 275 feet west of the northeast corner of sec. 22, T. 7 S., R. 11 W.

Ap—0 to 11 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; moderate coarse granular structure; very friable; slightly acid; abrupt smooth boundary.

A12—11 to 14 inches; very dark gray (10YR 3/1) loamy sand, brown (10YR 5/3) dry; few fine distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

B21g—14 to 23 inches; dark gray (10YR 4/1) sandy loam; few fine distinct brownish yellow (10YR 6/6) mottles; moderate coarse subangular blocky structure; friable; slightly acid; clear wavy boundary.

B22g—23 to 28 inches; dark gray (10YR 4/1) loamy sand; few medium distinct brownish yellow (10YR 6/8) mottles; weak medium subangular blocky structure; very friable; slightly acid; clear wavy boundary.

C1g—28 to 32 inches; grayish brown (10YR 5/2) sand; few medium distinct yellowish brown (10YR 5/4) mottles; single grain; loose; neutral; clear wavy boundary.

C2g—32 to 37 inches; grayish brown (10YR 5/2) fine sand; few fine distinct yellowish brown (10YR 5/8) mottles; massive; very friable; neutral; clear wavy boundary.

C3g—37 to 60 inches; grayish brown (10YR 5/2) sand; single grain; loose; neutral.

The solum ranges from 24 to 40 inches in thickness. I is slightly acid to neutral. The Ap or A1 ranges from 10 to 22 inches in thickness. The pebble and cobble content ranges from 0 to 10 percent throughout.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly sandy loam, but the range includes loamy sand and fine sandy loam. The B2g horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 c 2. It is sandy loam, sand, or loamy sand and has thin subhorizons of loam or sandy clay loam. The C horizon is sand, fine sand, or gravelly sand. It is neutral to

moderately alkaline. There are free carbonates in some pedons.

Hillsdale series

The Hillsdale series consists of well drained, moderately permeable soils on till plains and moraines. Hillsdale soils formed in loamy deposits. The slopes range from 2 to 18 percent.

Hillsdale soils are similar to Elmdale soils and are commonly adjacent to Elmdale, Riddles, and Teasdale soils. Elmdale soils are moderately well drained. Riddles soils are finer textured than Hillsdale soils and are in similar positions on the landscape. Teasdale soils are somewhat poorly drained and are in depressions and drainageways.

Typical pedon of Hillsdale sandy loam, 2 to 6 percent slopes, 60 feet west and 130 feet north of the southeast corner of sec. 5, T. 6 S., R. 10 W.

Ap—0 to 10 inches; dark brown (10YR 3/3) sandy loam, light brownish gray (10YR 6/2) dry; moderate coarse granular structure; friable; 5 percent pebbles; slightly acid; clear smooth boundary.

B21t—10 to 16 inches; yellowish brown (10YR 5/4) sandy loam; moderate medium angular blocky structure; friable; thin discontinuous clay films on faces of peds; 10 percent pebbles and cobbles; medium acid; clear wavy boundary.

B22t—16 to 31 inches; yellowish brown (10YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; thin discontinuous clay films on faces of peds; 10 percent pebbles and cobbles; medium acid; gradual wavy boundary.

B23t—31 to 45 inches; yellowish brown (10YR 5/6) sandy loam; moderate coarse subangular blocky structure; firm; thin discontinuous clay films on faces of peds; 15 percent pebbles and cobbles; medium acid; gradual wavy boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) sandy loam; massive; friable; 15 percent pebbles and cobbles; medium acid.

The solum ranges from 40 to more than 80 inches in thickness. Reaction ranges from slightly acid to very strongly acid. The pebble and cobble content ranges from 2 to 20 percent throughout.

The Ap horizon has value of 3 or 4 and chroma of 1 to 3. It is dominantly sandy loam, but the range includes fine sandy loam, loam, and loamy sand. There is an A2 horizon in some places. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is sandy loam, sandy clay loam, or loam. In some places there is a B3 horizon. The C horizon has value of 5 or 6 and chroma of 3 or 4. It is sandy loam or loamy sand. There are pockets of sand in some places.

Houghton series

The Houghton series consists of very poorly drained, moderately slowly permeable to moderately rapidly permeable soils on outwash plains, till plains, and lake plains. Houghton soils formed in organic deposits that are more than 51 inches thick. The slopes are less than 1 percent.

Houghton soils are commonly adjacent to Adrian, Cohoctah, and Palms soils. Adrian and Palms soils have organic material over mineral material. They are in positions on the landscape similar to those of the Houghton soils. Cohoctah soils have mineral horizons in which the organic matter content decreases irregularly as the depth increases. Cohoctah soils are on flood plains.

Typical pedon of Houghton muck, 2,470 feet west and 600 feet north of the southeast corner of sec. 7, T. 5 S., R. 12 W.

Oa1—0 to 11 inches; black (N 2/0) broken face and rubbed sapric material; less than 5 percent fiber; moderate medium subangular blocky structure parting to moderate medium crumb; friable; neutral; abrupt smooth boundary.

Oa2—11 to 17 inches; 70 percent black (5YR 2/1) and 30 percent black (N 2/0) broken face and black (5YR 2/1) rubbed sapric material; about 10 percent fiber, trace rubbed; moderate coarse subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

Oa3—17 to 28 inches; black (N 2/0) broken face and rubbed sapric material; about 10 percent fiber, trace rubbed; moderate thick platy structure; firm; slightly acid; abrupt smooth boundary.

Oa4—28 to 45 inches; black (10YR 2/1) broken face and black (N 2/0) rubbed sapric material; about 20 percent fiber, trace rubbed; weak medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

Oa5—45 to 60 inches; dark reddish brown (5YR 2/2) broken face, black (5YR 2/1) rubbed sapric material; about 20 percent fiber, trace rubbed; weak fine subangular blocky structure; very friable; slightly acid.

The organic layers are more than 51 inches thick. Reaction ranges from slightly acid to neutral throughout the pedon. In some places there are woody fragments, 1 to 8 inches in diameter, that cannot be crushed between the fingers.

Layers within the control section have hue of 10YR, 7.5YR, or 5YR, or they are neutral. They have value of 2 or 3 and chroma of 0 to 3. Chroma may change 1 to 2 units from the broken face to the rubbed colors. The layers are predominantly sapric material, but in some pedons they are hemic material and have a combined thickness of less than 10 inches.

Kalamazoo series

The Kalamazoo series consists of well drained soils on outwash plains. Kalamazoo soils formed in loamy and sandy sediments. Permeability is moderate in the upper part of the solum and rapid in the lower part. The slopes range from 0 to 12 percent.

Kalamazoo soils are similar to Schoolcraft soils and are commonly adjacent to Matherton, Oshtemo, and Schoolcraft soils. Matherton soils are somewhat poorly drained and are on lowlands and in drainageways. Oshtemo soils are coarser textured than Kalamazoo soils and are in similar positions on the landscape. Schoolcraft soils have a mollic epipedon.

Typical pedon of Kalamazoo loam, 0 to 6 percent slopes, 330 feet north and 247 feet west of the center of sec. 6, T. 5 S., R. 11 W.

Ap—0 to 12 inches; very dark grayish brown (10YR 3/2) loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

B21t—12 to 20 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; thin continuous clay films on faces of peds; 5 percent pebbles; slightly acid; clear wavy boundary.

B22t—20 to 23 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine subangular blocky structure; friable; thin continuous clay films on faces of peds; 1 percent pebbles; strongly acid; clear wavy boundary.

B23t—23 to 28 inches; dark brown (7.5YR 4/4) sandy loam; moderate fine subangular blocky structure; friable; thin continuous clay films on faces of peds; 1 percent pebbles; strongly acid; abrupt wavy boundary.

B24t—28 to 34 inches; dark brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; thin continuous clay films on faces of peds and clay bridging of sand grains; 5 percent pebbles; strongly acid; abrupt wavy boundary.

IIB31—34 to 38 inches; yellowish brown (10YR 5/6) loamy sand; weak fine subangular blocky structure; very friable; 10 percent pebbles; strongly acid; clear wavy boundary.

IIB32—38 to 76 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; 10 percent pebbles; slightly acid.

The solum ranges from 40 to 84 inches in thickness. It is strongly acid to neutral. The depth to the IIB horizon ranges from 25 to 40 inches. The content of pebbles ranges from 1 to 20 percent throughout.

The Ap horizon has chroma of 2 to 4; the dry value is 6 or more. The Ap horizon is dominantly loam, but the range includes sandy loam. There is an A1 horizon in some places. It is 2 to 6 inches thick and has chroma of 2 or 3. In some places there is an A2 horizon. The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. The upper part of the B2t horizon is sandy loam, sandy clay loam, loam, or clay loam. The lower part is sandy loam or loamy sand. The IIB3 horizon has value of 4 to 6 and chroma of 3 to 6. It is loamy sand or sand. In some places there is a IIC horizon that has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is sand or gravelly sand.

Matherton series

The Matherton series consists of somewhat poorly drained soils on outwash plains. Matherton soils formed in loamy and sandy deposits underlain by gravelly sand. Permeability is moderate in the upper part of the soil and rapid in the lower part. The slopes range from 0 to 3 percent.

Matherton soils are commonly adjacent to Kalamazoo and Sebewa soils. Kalamazoo soils are well drained and are in higher positions on the landscape. The Sebewa soils are poorly drained or very poorly drained. They are in shallow depressions and in drainageways.

Typical pedon of Matherton loam, 0 to 3 percent slopes, 50 feet south and 595 feet east of the northwest corner of sec. 7, T. 5 S., R. 12 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, pale brown (10YR 6/3) dry; moderate coarse granular structure; friable; mildly alkaline; abrupt smooth boundary.

A2—9 to 11 inches; pale brown (10YR 6/3) loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; neutral; abrupt broken boundary.

B21tg—11 to 22 inches; grayish brown (10YR 5/2) clay loam; common medium distinct strong brown (7.5YR 5/8) mottles; moderate coarse subangular blocky structure; firm; thin continuous clay films on faces of peds; slightly acid; clear wavy boundary.

B22tg—22 to 28 inches; light brownish gray (10YR 6/2) clay loam; few fine faint grayish brown (10YR 5/2) and common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin continuous clay films on faces of peds; slightly acid; clear wavy boundary.

B23tg—28 to 32 inches; grayish brown (10YR 5/2) sandy clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; friable; thin discontinuous clay films on faces of peds; slightly acid; abrupt wavy boundary.

IIB3t—32 to 65 inches; yellowish brown (10YR 5/4) loamy sand; few fine faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; clay bridging of sand grains; slightly acid; abrupt wavy boundary.

IICg—65 to 70 inches; dark grayish brown (10YR 4/2) gravelly sand; single grain; loose; strong effervescence; moderately alkaline.

The solum ranges from 40 to 70 inches in thickness. It is slightly acid to mildly alkaline. The pebble content ranges from 0 to 10 percent throughout.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3; the dry value is 6 or more. The B2t horizon has value of 5 or 6. It is clay loam, loam, or sandy clay loam. The IIC horizon has value of 4 to 6. It is sand or gravelly sand.

Nottawa series

The Nottawa series consists of moderately well drained soils on outwash plains. Nottawa soils formed in loamy and sandy sediments. Permeability is moderately rapid in the upper part of the pedon and rapid in the lower part. The slopes range from 0 to 3 percent.

Nottawa soils are similar to Elston and Oshtemo soils and are commonly adjacent to Oshtemo soils. Elston soils are well drained. Oshtemo soils are well drained, and unlike Nottawa soils they do not have a mollic epipedon.

Typical pedon of Nottawa sandy loam, 0 to 3 percent slopes, 1,650 feet north and 330 feet east of the southwest corner of sec. 3, T. 6 S., R. 10 W.

Ap—0 to 11 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; friable; medium acid; abrupt smooth boundary.

B21t—11 to 15 inches; dark brown (10YR 3/3) sandy loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; friable; thin continuous dark grayish brown (10YR 3/2) clay films on faces of peds; 10 percent pebbles and cobbles; medium acid; clear smooth boundary.

B22t—15 to 23 inches; dark yellowish brown (10YR 3/4) sandy loam; weak medium subangular blocky structure; friable; thin continuous very dark grayish brown (10YR 3/2) clay films on faces of peds; 10 percent pebbles and cobbles; medium acid; gradual wavy boundary.

B23t—23 to 28 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; thin dark brown (10YR 3/3) clay coatings on sand grains and as bridging between sand grains; 5 percent pebbles; medium acid; gradual wavy boundary.

B24t—28 to 33 inches; yellowish brown (10YR 5/4) loamy sand; common fine faint yellowish brown (10YR 5/8) and few fine faint dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; very friable; thin dark brown (10YR 3/3) clay coatings on sand grains and as bridging between sand grains; 5 percent pebbles; medium acid; clear wavy boundary.

B3—33 to 46 inches; dark brown (7.5YR 4/4) sand; few coarse faint strong brown (7.5YR 5/8) mottles; single grain; loose; 5 percent pebbles; slightly acid; clear wavy boundary.

C—46 to 60 inches; pale brown (10YR 6/3) sand; common fine distinct yellow (10YR 7/6) and brownish yellow (10YR 6/8) mottles and many medium distinct dark brown (7.5YR 4/4) mottles; single grain; loose; slightly acid.

The solum is 40 to 72 inches thick. The pebble and cobble content ranges from 0 to 15 percent throughout.

The Ap horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly sandy loam, but in some pedons it is loam. It ranges from neutral to strongly acid. The B2t horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5; and chroma of 3 or 4. It is typically sandy loam or loam and has individual horizons of sandy clay loam or loamy sand. It ranges from medium acid to very strongly acid. The C horizon ranges from medium acid to moderately alkaline. Calcareous sand and gravelly sand generally are at a depth of 5 to 10 feet.

Oshtemo series

The Oshtemo series consists of well drained, moderately rapidly permeable soils on outwash plains and moraines. The soils formed in loamy and sandy sediments. The slopes range from 0 to 18 percent.

Oshtemo soils are similar to Bronson, Elston, and Nottawa soils and are commonly adjacent to Brady, Elston, Kalamazoo, and Nottawa soils. Brady soils are somewhat poorly drained and are in depressions and drainageways. Bronson soils are moderately well drained. Elston soils have a darker surface layer than Oshtemo soils. Kalamazoo soils are finer textured than Oshtemo soils and are in similar positions on the landscape. Nottawa soils are moderately well drained and have a mollic epipedon.

Typical pedon of Oshtemo sandy loam, 0 to 6 percent slopes, 880 feet east and 800 feet north of the southwest corner of sec. 18, T. 6 S., R. 10 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; weak coarse granular structure; very friable; slightly acid; abrupt smooth boundary.

A2—9 to 14 inches; brown (10YR 5/3) sandy loam; weak fine subangular blocky structure; very friable; many worm and root channels filled with Ap material; 3 percent pebbles; medium acid; clear wavy boundary.

B21t—14 to 26 inches; dark reddish brown (5YR 3/4) sandy loam, dark brown (7.5YR 4/4) dry; weak coarse subangular blocky structure; friable; thin discontinuous clay films on faces of peds; 8 percent pebbles; strongly acid; clear wavy boundary.

B22t—26 to 35 inches; dark brown (7.5YR 4/4) sandy loam; weak coarse subangular blocky structure; friable; few dark brown (7.5YR 3/2) chunks 1 to 3 inches in diameter; thin discontinuous clay films on faces of peds; some clay bridging between sand grains and small pebbles; 5 percent pebbles; strongly acid; gradual wavy boundary.

B31—35 to 46 inches; dark brown (7.5YR 4/4) loamy sand; many dark brown (7.5YR 3/2) spots and chunks up to 2 inches in diameter; single grain; loose; 5 percent pebbles; medium acid; diffuse irregular boundary.

B32—46 to 60 inches; dark brown (7.5YR 4/4) loamy sand; dark brown (7.5YR 3/2) discontinuous bands 1/8 inch thick; most sand grains have dark brown (7.5YR 3/2) coatings; single grain; loose; medium acid; abrupt irregular boundary.

IIC—60 to 66 inches; grayish brown (10YR 5/2) gravelly sand; single grain; loose; thin lime coatings on the lower side of some pebbles; strong effervescence; moderately alkaline.

The solum is 40 to 66 inches thick. It is slightly acid to strongly acid. In some places the lower part of the B3 horizon is neutral. The pebble and cobble content ranges from 1 to 30 percent throughout the soil.

The Ap horizon has value of 3 to 5 and chroma of 2 or 3. It is dominantly sandy loam, but the range includes loamy sand. The Bt horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5; and chroma of 3 to 6. It is sandy loam, gravelly sandy loam, sandy clay loam, or gravelly sandy clay loam. In some places, the Bt horizon consists of layers 1/8 inch to 4 inches thick separated by loamy sand. The IIC horizon has chroma of 2 or 3. It is stratified coarse sand and fine gravel or gravelly sand.

Palms series

The Palms series consists of very poorly drained soils on lake plains, outwash plains, and till plains. Palms soils formed in organic deposits 16 to 50 inches thick over loamy deposits. Permeability is moderately slow to moderately rapid in the organic material and moderately slow or moderate in the underlying layers. The slopes are less than 1 percent.

Palms soils are similar to Adrian soils and are commonly adjacent to Adrian and Houghton soils. Adrian soils formed in organic deposits 16 to 50 inches thick over sandy materials. Houghton soils consist of organic matter to a depth more than 51 inches.

Typical pedon of Palms muck, 1,060 feet south and 396 feet east of the northwest corner of sec. 30, T. 5 S., R. 9 W.

Oa1—0 to 10 inches; black (10YR 2/1) broken face and rubbed sapric material; about 3 percent fiber, less than 1 percent rubbed; weak medium subangular blocky structure; slightly sticky; slightly acid; clear wavy boundary.

Oa2—10 to 14 inches; black (5YR 2/1) broken face and rubbed sapric material; about 15 percent fiber, less than 1 percent rubbed; weak medium subangular blocky structure; slightly sticky; slightly acid; clear wavy boundary.

Oa3—14 to 21 inches; black (10YR 2/1) broken face and rubbed sapric material; about 15 percent fiber, less than 1 percent rubbed; weak medium platy structure; slightly sticky; slightly acid; abrupt smooth boundary.

IIC1g—21 to 55 inches; dark gray (5Y 4/1) silt loam; 1 percent coarse fragments; massive; slightly sticky; neutral; clear wavy boundary.

IIC2g—55 to 60 inches; dark gray (5Y 4/1) sandy loam; 1 percent coarse fragments; massive; slightly sticky; neutral.

The depth to the loamy IIC horizon ranges from 16 to 50 inches. In some places there are woody fragments less than 6 inches in diameter in the soil. The organic material ranges from medium acid to mildly alkaline.

The surface tier has hue of 10YR or 7.5YR, or it is neutral, and it has chroma of 0 or 1. The subsurface and bottom tiers have hue of 10YR, 7.5YR, or 5YR, or it is neutral. It has value of 2 or 3 and chroma of 0 to 3. The organic part of the subsurface and bottom tiers is primarily sapric material; however, in some places there are thin layers of hemic material that have a combined thickness of less than 10 inches. The IICg horizon has hue of 10YR, 5YR, or 2.5Y; value of 4 to 7; and chroma of 1 or 2. It is sandy loam, fine sandy loam, loam, silt loam, or silty clay loam. It ranges from slightly acid to mildly alkaline. In some places there are thin layers of loamy sand.

Riddles series

The Riddles series consists of well drained, moderately permeable soils on till plains and moraines. Riddles soils formed in loamy and sandy deposits. The slopes range from 2 to 18 percent.

Riddles soils are commonly adjacent to Hillsdale soils. Hillsdale soils are coarser textured than Riddles soils. They are in positions on the landscape similar to those of the Riddles soils.

Typical pedon of Riddles sandy loam, 6 to 18 percent slopes, 1,380 feet west and 55 feet south of the northeast corner of sec. 15, T. 5 S., R. 12 W.

Ap—0 to 9 inches; brown (10YR 4/3) sandy loam; moderate fine subangular blocky structure; friable; 3 percent pebbles; neutral; abrupt smooth boundary.

B21t—9 to 17 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate medium subangular blocky structure; firm; 3 percent pebbles; neutral; clear wavy boundary.

B22t—17 to 22 inches; yellowish brown (10YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; 3 percent pebbles and cobbles; slightly acid; clear wavy boundary.

B23t—22 to 30 inches; yellowish brown (10YR 5/6) sandy loam; moderate fine subangular blocky structure; friable; 3 percent pebbles and cobbles; slightly acid; clear wavy boundary.

B24t—30 to 43 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; friable; 3 percent pebbles and cobbles; medium acid; gradual wavy boundary.

B3—43 to 55 inches; dark yellowish brown (10YR 4/4) sandy loam; massive; friable; 3 percent pebbles and cobbles; strongly acid; clear wavy boundary.

C—55 to 60 inches; dark yellowish brown (10YR 4/4) loamy sand; massive; very friable; 3 percent pebbles and cobbles; slightly acid.

The solum ranges from 40 to 72 inches in thickness, but it is typically 43 to 60 inches thick. It is very strongly acid to moderately alkaline. The pebble and cobble content ranges from 1 to 10 percent throughout the soil.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. It is dominantly sandy loam, but the range includes loam. In some places there is an A2 horizon. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is sandy loam, loam, sandy clay loam, and clay loam. The C horizon has value of 3 to 5 and chroma of 3 to 6. It is sandy loam or loamy sand and ranges from slightly acid to moderately alkaline. In some places there are pockets or strata of sand.

Schoolcraft series

The Schoolcraft series consists of well drained soils on outwash plains. Schoolcraft soils formed in loamy over sandy sediments. Permeability is moderate in the upper part of the pedon and rapid in the lower part. The slopes range from 0 to 6 percent.

Schoolcraft soils are similar and commonly adjacent to Kalamazoo soils. Kalamazoo soils do not have a mollic epipedon.

Typical pedon of Schoolcraft loam, 0 to 4 percent slopes, 2,240 feet south and 990 feet west of the northeast corner of sec. 1, T. 5 S., R. 12 W.

Ap—0 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

B21t—11 to 17 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; firm; thick continuous clay films on faces of peds; slightly acid; clear wavy boundary.

B22t—17 to 23 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate medium subangular blocky structure; friable; thin continuous clay films on faces of peds; slightly acid; clear wavy boundary.

B23t—23 to 31 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; thin continuous clay films on faces of peds; slightly acid; clear wavy boundary.

IIC1—31 to 70 inches; yellowish brown (10YR 5/6) loamy sand; weak medium granular structure; very friable; slightly acid; gradual wavy boundary.

IIC2—70 to 75 inches; pale brown (10YR 6/3) gravelly sand; single grain; loose; strong effervescence; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. It is slightly acid to strongly acid except for the mollic epipedon, which is slightly acid or neutral. The depth to sand or gravelly sand ranges from 30 to 70 inches. The pebble content ranges from 0 to 5 percent throughout the solum.

The Ap horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 to 3. It is dominantly loam, but the range includes sandy loam and silt loam. The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. It is clay loam, sandy clay loam, sandy loam, or loam. There is a IIB3 horizon in some places. The IIC horizon has value of 4 to 6 and chroma of 2 to 6. It is loamy sand, sand, or gravelly sand. The pebble and cobble content ranges from 0 to 20 percent. Reaction is mildly alkaline or moderately alkaline at a depth of 5 to 8 feet.

Sebewa series

The Sebewa series consists of poorly drained or very poorly drained soils on outwash plains. Sebewa soils formed in loamy deposits over sandy deposits. Permeability is moderate in the upper part of the pedon and rapid in the lower part. The slopes range from 0 to 2 percent.

Sebewa soils are commonly adjacent to Adrian and Granby soils. Adrian soils have 16 to 50 inches of organic material over sandy deposits. They are in similar or slightly lower positions on the landscape. Granby soils are coarser textured than Sebewa soils. They are in similar positions on the landscape.

Typical pedon of Sebewa loam, 1,425 feet west and 900 feet south of the northeast corner of sec. 30, T. 5 S., R. 10 W.

Ap—0 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate coarse subangular blocky structure parting to moderate coarse granular; friable; 5 percent pebbles; neutral; clear wavy boundary.

B21tg—13 to 20 inches; dark gray (10YR 4/1) sandy clay loam; few fine distinct reddish yellow (7.5YR 7/8) mottles; massive; firm; thick discontinuous clay films on faces of peds; 10 percent pebbles and cobbles; slightly acid; clear wavy boundary.

B22tg—20 to 28 inches; dark gray (10YR 4/1) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; thick continuous clay films; 10 percent pebbles and cobbles; neutral; clear smooth boundary.

IIC1g—28 to 33 inches; gray (10YR 5/1) sand; single grain; loose; 10 percent pebbles and cobbles; neutral; clear smooth boundary.

IIC2g—33 to 60 inches; grayish brown (10YR 5/2) gravelly sand; single grain; loose; 30 percent pebbles and cobbles; slight effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. It is slightly acid to mildly alkaline. In some places there are carbonates below a depth of 18 inches. The pebble and cobble content ranges from 0 to 15 percent in the upper horizons and from 5 to 25 percent in the lower part of the B2 horizon.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes silt loam and sandy loam. The B2tg horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 6; and chroma of 1 or 2. It is sandy clay loam, clay loam, loam, or gravelly clay loam. The IIC horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6; and chroma of 1 or 2. It is sand, coarse sand, stratified sand and gravel, or gravelly sand.

Spinks series

The Spinks series consists of well drained, moderately rapidly permeable soils on outwash plains and moraines. Spinks soils formed in sandy deposits. The slopes range from 0 to 18 percent.

Spinks soils are commonly adjacent to Brady, Bronson, Elston, and Oshtemo soils. Brady soils are somewhat poorly drained, have a continuous argillic horizon, and are in depressions and drainageways. Bronson soils are moderately well drained and have a continuous argillic horizon. They are in slightly lower positions on the landscape than those of the Spinks soils. Elston soils have a mollic epipedon and a continuous argillic horizon. They are in similar or slightly lower positions on the landscape. Oshtemo soils have a continuous argillic horizon. They and the Spinks soils are in similar positions on the landscape.

Typical pedon of Spinks loamy sand, 0 to 6 percent slopes, 1,914 feet north and 100 feet east of the southwest corner of sec. 15, T. 5 S., R. 11 W.

Ap—0 to 10 inches; dark brown (10YR 3/3) loamy sand, light brownish gray (10YR 6/2) dry; moderate fine granular structure; very friable; slightly acid; abrupt smooth boundary.

A2—10 to 26 inches; yellowish brown (10YR 5/6) loamy sand; weak fine subangular blocky structure; very friable; neutral; clear wavy boundary.

A&B—26 to 60 inches; yellowish brown (10YR 5/6) sand (A2 part); single grain; loose; lamellae or bands of dark brown (7.5YR 4/4) loamy sand (B2t part); weak fine subangular blocky structure; very friable; slightly acid.

The solum ranges from 36 inches to more than 60 inches in thickness. It is medium acid to neutral. The pebble and cobble content ranges from 0 to 10 percent throughout the soil.

The Ap horizon has value of 3 to 5 and chroma of 2 to 4. It is dominantly loamy sand, but the range includes sand. The A2 part of the A&B horizon has value of 5 or 6 and chroma of 3 to 6. It is loamy sand or sand. The B2t part of the A&B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. In some place there is a C horizon. It has value of 5 to 7 and chroma of 3 or 4. It is sand and ranges from neutral to moderately alkaline.

Teasdale series

The Teasdale series consists of somewhat poorly drained, moderately permeable soils on till plains and moraines. Teasdale soils formed in loamy and sandy deposits. The slopes range from 0 to 4 percent.

Teasdale soils are similar to Elmdale soils and are commonly adjacent to Barry and Hillsdale soils. Barry soils are poorly drained. They are finer textured than the Teasdale soils. They are in depressions and drainageways. Elmdale soils are moderately well drained. Hillsdale soils are well drained. They are in higher positions on the landscape than those of the Teasdale soils.

Typical pedon of Teasdale sandy loam, 0 to 4 percent slopes, 88 feet west and 413 feet north of the southeast corner of sec. 11, T. 6 S., R. 10 W.

A1—0 to 6 inches; very dark grayish brown (10YR 3/2) sandy loam, pale brown (10YR 6/3) dry; moderate medium granular structure; friable; 2 percent pebbles; slightly acid; gradual wavy boundary.

A2—6 to 13 inches; pale brown (10YR 6/3) sandy loam; weak fine subangular blocky structure; friable; 2 percent pebbles; strongly acid; gradual wavy boundary.

B&A—13 to 17 inches; yellowish brown (10YR 5/4) sandy clay loam (B2t part) with coatings more than 2 millimeters thick of pale brown (10YR 6/3) sandy loam (A2 part); common fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; thin discontinuous clay films; 2 percent pebbles; strongly acid; gradual wavy boundary.

B21t—17 to 21 inches; yellowish brown (10YR 5/4) loam; common medium distinct light brownish gray (10YR 6/2) and common coarse prominent yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; friable; thick continuous clay films; 3 percent pebbles; strongly acid; clear wavy boundary.

B22t—21 to 26 inches; yellowish brown (10YR 5/4) sandy loam; common coarse prominent yellowish red (5YR 5/8) mottles; moderate fine subangular blocky structure; friable; thin discontinuous clay films; 3 percent pebbles; strongly acid; clear wavy boundary.

B3—26 to 48 inches; yellowish brown (10YR 5/4) loamy sand; comon medium prominent yellowish red (5YR 4/8) mottles; moderate thick platy structure parting to moderate fine subangular blocky; friable; 3 percent pebbles; slightly acid; gradual wavy boundary.

C—48 to 60 inches; light yellowish brown (10YR 6/4) loamy sand; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; 5 percent pebbles and cobbles; slight effervescence; moderately alkaline.

The solum is 40 to 60 inches thick. The depth to free carbonates ranges from 40 to more than 60 inches. The pebble and cobble content ranges from 1 to 20 percent throughout.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. It is dominantly sandy loam, but the range includes fine sandy loam. This horizon is gravelly or cobbly in some places. The A2 horizon has value of 5 or 6 and chroma of 2 or 3. It has the same texture as the Ap horizon. Undisturbed areas have an A1 horizon. The B part of the B&A horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is loam, sandy loam, or sandy clay loam or their gravelly or cobbly analogs. The A part of the B&A horizon has coatings 2 to 5 millimeters thick on the vertical faces of peds. The peds are A2 material that have the same colors as those described for the A2 horizon. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy clay loam, sandy loam, or loam or their gravelly or cobbly analogs. The C horizon ranges from neutral to moderately alkaline.

formation of the soils

This section describes the factors of soil formation, relates them to the formation of soils in St. Joseph County, and discusses the processes of soil formation.

factors of soil formation

Soil forms through the interaction of five major factors: the physical, chemical, and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the processes of soil formation have acted on the parent material.

Climate and plants and animals are the active forces in soil formation. They slowly change the parent material into a natural body of soil that has genetically related layers called horizons. The effects of climate and of plant and animal life are conditioned by relief. The nature of the parent material also affects the kind of soil profile that is formed. In extreme cases, it determines the profile almost entirely. Finally, time changes the parent material into a soil. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on soils that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

parent material

Parent material, the unconsolidated mass in which a soil forms, determines the limits of the chemical and mineralogical composition of the soil. The parent material of the soils in St. Joseph County was deposited by glaciers or by melt water from glaciers that covered the county 10,000 to 12,000 years ago. Some of this material was subsequently reworked and redeposited by water and wind. Although most parent material is of common glacial origin, its properties vary greatly, sometimes within small areas, depending on how the material was deposited. The dominant parent materials in St. Joseph County were deposited as glacial till, outwash deposits, alluvium, and organic material.

Glacial till is material laid down directly by glaciers with minimal water action. It conists of a mixture of particles of different sizes. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water washing. The glacial till in St. Joseph County is calcareous sandy loam or loam. Riddles soils, for example, formed in glacial till. Typically, they are loamy and have a moderately well developed structure.

Outwash materials consist of particles that were deposited by running water from melting glaciers. The size of the particles depends on the speed of the water that carried them. As the speed of the stream decreases, the coarser particles are deposited. Slowly moving water can carry finer particles, such as very fine sand, silt, and clay. Outwash deposits generally consist of layers of particles of similar size, such as sandy loam, sand, gravel, and other coarse particles. Kalamazoo soils, for example, formed in outwash material.

Alluvium has been deposited by floodwaters of present streams in recent time. The texture of this material is determined by the speed of the water that deposited the material. Alluvium deposited by a swift stream is coarser than that deposited by a slow, sluggish stream. Cohoctah soils formed in alluvial material.

Organic material is made up of plant remains. After the glaciers receded from the county, water was left standing in depressions in outwash plains and till plains. Grasses and sedges grew around the edges of these depressions. Because of the wetness, when the plant died their remains did not decompose but accumulated around the edge of the depression. Later, water-tolerant trees grew in these areas. As the trees died, their remains became part of the organic accumulation. The depressions eventually filled with organic material and developed into areas of muck. Houghton soils formed in organic material.

plant and animal life

Green plants have been the principal organisms influencing the soils in St. Joseph County. Bacteria, fungi, earthworms, and man have also been important. Plants and animals contribute organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends on the kinds of plants that grow on the soil. The remains of plants accumulate on the surface; they decay and eventually become organic matter. Plant roots provide channels for the downward movement of water through the soil and add organic matter as the plant roots decay. Bacteria in the soil help break down the organic matter into a form that can be used by growing plants.

The native vegetation in St. Joseph County is mainly deciduous forest. Differences in natural soil drainage and changes in parent material affect the composition of the forest species.

In general, the vegetation on the well drained upland soils, such as Kalamazoo and Oshtemo soils, is maple, oak, and hickory. The vegetation on Spinks soils is scrub oak. In general, soft maple, elm, and ash grow on wet soils. Granby and Sebewa soils formed under wet conditions and contain a considerable amount of organic matter. Prairie grass is dominant on Schoolcraft, Elston, and Nottawa soils.

climate

Climate determines the kind of plant and animal life on and in the soil and the amount of water available for weathering minerals and transporting soil material. Through its influence on soil temperature, climate determines the rate of chemical reaction in the soil. Climatic influences generally affect areas larger than a county.

The climate in St. Joseph County is cool and humid. Presumably it is similar to the climate in which the soils formed. The soils in the county differ from soils that formed in a dry, warm climate or in a moist, hot climate. Although climate is uniform throughout the county, its effect is modified locally, depending on proximity to large lakes. The different effects, however, have resulted in only minor differences in the soils in St. Joseph County.

relief

Relief has had a marked influence on the formation of soils in St. Joseph County. Natural drainage, erosion, plant cover, and soil temperature are affected by relief. In St. Joseph County, slopes range from 0 to 18 percent. Natural soil drainage ranges from excessive (soils on ridgetops) to very poor (soils in depressions).

Relief influences the formation of soils by its effect on runoff and drainage. Drainage, in turn, through its effect on soil aeration, determines the color of the soil. Runoff is most rapid on the steeper slopes, but in low areas water ponds temporarily. Water and air move freely through soils that are well drained, but they move slowly through soils that are very poorly drained. In well aerated soils, the iron and aluminum compounds are brightly colored and oxidized. Poorly aerated soils are dull gray and mottled. Kalamazoo soils are well drained and well aerated. Sebewa soils are very poorly drained and poorly aerated. Both soils, however, formed in similar parent material.

time

Generally, a long time is required for the development of distinct horizons in a soil. Differences in the length of time that the parent material has been in place are commonly reflected in the degree of horizonal development in the soil. Some soils develop rapidly, and others develop slowly.

The soils in St. Joseph County range from young to mature. Glacial deposits, in which many of the soils in the county formed, have been exposed to soil forming processes long enough for distinct horizons to develop. Recent alluvial sediment, on the other hand, has not been in place long, and distinct horizons have not formed.

Cohoctah soils, which formed in alluvial material, are young soils. Kalamazoo soils, which formed in loamy and sandy sediments on outwash plains, are mature soils.

processes of soil formation

The processes that result in the development of soil horizons from unconsolidated parent material are known as soil genesis. The physical, chemical, and biological properties of the various soil horizons are known as soil morphology.

Several processes are involved in the development of soil horizons: (1) accumulation of organic matter, (2) leaching of lime (calcium carbonates) and other bases, (3) reduction and transfer of iron, and (4) formation and translocation of silicate clay minerals. In most soils, more than one of these processes has been active in the development of distinct horizons.

Organic matter accumulates on the surface to form an A1 horizon. The A1 horizon is mixed into a plow layer, or Ap horizon, if the soil is plowed. In St. Joseph County, the organic matter content of the surface layer ranges from high to low. In Sebewa soils, for example, the content of organic matter in the surface layer is high. In Spinks soils, the content is low.

Carbonates and other bases have been leached from most of the soils. Leaching of bases is generally believed to precede the translocation of silicate clay minerals. Many of the soils in St. Joseph County are moderately to strongly leached. Riddles soils, for example, are leached of carbonates to a depth of 55 inches. Sebewa soils, on the other hand, are leached to a depth of only 28 inches. Differences in the depth of leaching are a result of the length of time a soil has been forming.

The reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained, poorly drained, and very poorly drained soils. The gray color of the subsoil indicates the reduction and loss of iron. Sebewa soils, for example, exhibit gleying.

In some soils, the translocation of clay minerals has contributed to horizon development. The eluviated, or leached, A3 horizon typically has platy structure, is lower in content of clay, and is lighter in color than the illuviated B horizon. The B horizon typically has an accumulation of clay or clay films in pores and on ped surfaces. Soils displaying translocation of clay were probably leached of carbonates and soluble salts to a

considerable extent before the translocation of silicate clay occurred. Leaching of bases and translocation of silicate clay are two of the most important processes in horizon differentiation in soils. Riddles soils have translocated silicate clay in the form of clay films that have accumulated in the B horizon.

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glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a

catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet

and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma.

For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1949-78 at Three Rivers, Michigan]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	31.4	16.0	23.7	58	-12	0	1.99	.9	2.9	5	10.1
February---	35.1	18.0	26.5	58	-11	0	1.63	.7	2.4	4	9.3
March------	45.0	26.4	35.7	75	1	18	2.49	1.5	3.4	6	7.0
April------	59.9	37.0	48.5	83	18	107	3.44	1.9	4.8	8	1.9
May--------	71.7	46.9	59.3	89	27	318	3.09	1.7	4.3	7	<.10
June-------	81.0	56.3	68.6	95	38	566	4.03	2.4	5.5	7	.0
July-------	84.1	59.7	71.9	96	44	688	3.87	2.3	5.3	7	.0
August-----	82.5	57.7	70.1	95	40	631	2.96	1.4	4.3	5	.0
September--	75.6	50.6	63.1	93	30	405	3.10	1.6	4.4	6	.0
October----	64.5	40.7	52.6	85	20	164	2.62	1.2	3.9	5	0.3
November---	48.0	31.2	39.6	73	7	28	2.35	1.6	3.0	6	5.5
December---	35.6	21.1	28.4	61	-7	0	2.40	1.1	3.5	6	11.4
Year------	59.5	38.5	49.0	97	-14	2,922	33.97	28.7	39.0	72	45.6

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1930-74 at Three Rivers, Michigan]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 25	May 12	May 21
2 years in 10 later than--	April 21	May 7	May 17
5 years in 10 later than--	April 12	April 27	May 8
First freezing temperature in fall:			
1 year in 10 earlier than--	October 16	October 2	September 19
2 years in 10 earlier than--	October 22	October 7	September 25
5 years in 10 earlier than--	November 2	October 18	October 5

TABLE 3.--GROWING SEASON

[Recorded in the period 1930-74 at Three Rivers, Michigan]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	182	154	129
8 years in 10	190	161	135
5 years in 10	204	174	149
2 years in 10	218	187	163
1 year in 10	225	193	170

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Histosols and Aquents, ponded	5,790	1.8
4B	Oshtemo sandy loam, 0 to 6 percent slopes	90,715	28.0
4C	Oshtemo sandy loam, 6 to 12 percent slopes	8,780	2.7
4D	Oshtemo sandy loam, 12 to 18 percent slopes	3,565	1.1
5B	Spinks loamy sand, 0 to 6 percent slopes	43,870	13.6
5C	Spinks loamy sand, 6 to 12 percent slopes	7,550	2.3
5D	Spinks loamy sand, 12 to 18 percent slopes	5,615	1.7
8A	Nottawa sandy loam, 0 to 3 percent slopes	2,855	0.9
9A	Elston sandy loam, 0 to 3 percent slopes	7,700	2.4
10B	Hillsdale sandy loam, 2 to 6 percent slopes	22,400	7.0
10C	Hillsdale sandy loam, 6 to 12 percent slopes	10,780	3.3
10D	Hillsdale sandy loam, 12 to 18 percent slopes	7,710	2.4
12A	Brady sandy loam, 0 to 2 percent slopes	7,890	2.4
13	Granby sandy loam	8,445	2.6
14	Sebewa loam	5,950	1.8
15	Cohoctah loam	5,840	1.8
16B	Elmdale sandy loam, 1 to 6 percent slopes	5,815	1.8
17B	Teasdale sandy loam, 0 to 4 percent slopes	6,725	2.1
18	Barry loam	1,955	0.6
19	Houghton muck	15,155	4.7
20A	Bronson sandy loam, 0 to 3 percent slopes	7,315	2.3
21A	Matherton loam, 0 to 3 percent slopes	795	0.2
24	Adrian muck	8,920	2.8
25	Pits	835	0.3
26	Palms muck	480	0.1
27B	Kalamazoo loam, 0 to 6 percent slopes	12,020	3.7
27C	Kalamazoo loam, 6 to 12 percent slopes	760	0.2
28B	Riddles sandy loam, 2 to 6 percent slopes	1,595	0.5
28C	Riddles sandy loam, 6 to 18 percent slopes	4,765	1.5
29B	Schoolcraft loam, 0 to 4 percent slopes	235	0.1
30B	Urban land-Oshtemo complex, 0 to 6 percent slopes	4,890	1.5
31B	Udorthents, loamy	140	0.1
32	Dumps	105	*
33A	Urban land-Elston complex, 0 to 3 percent slopes	2,950	0.9
	Water	2,674	0.8
	Total	323,584	100.0

* Less than 0.1 percent.

TABLE 5.--CAPABILITY AND YIELDS PER ACRE OF CROPS

[Yields in the N columns are for nonirrigated soils; those in the I columns are for irrigated soils. Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Capability subclass		Corn		Corn silage		Soybeans		Legume hay		Oats	Winter wheat
	N	I	N	I	N	I	N	I	N	I	N	N
			Bu	Bu	Ton	Ton	Bu	Bu	Ton	Ton	Bu	Bu
2. Histosols and Aquents	VIIIw	---	---	---	---	---	---	---	---	---	---	---
4B. Oshtemo	IIIs	IIIs	90	175	15	27	30	57	2.5	8.0	80	42
4C. Oshtemo	IIIe	IIIe	85	165	14	25	26	50	2.5	7.0	75	37
4D. Oshtemo	IVe	---	75	---	13	---	21	---	2.2	---	70	32
5B. Spinks	IIIs	IIIs	75	165	13	24	27	50	3.0	7.0	60	30
5C. Spinks	IIIe	IIIe	68	160	12	23	23	50	2.4	7.0	55	30
5D. Spinks	IVe	---	---	---	---	---	---	---	1.8	---	50	24
8A. Nottawa	IIs	IIs	95	180	16	27	30	55	4.0	8.0	80	45
9A. Elston	IIs	---	90	180	16	27	32	55	3.0	---	---	40
10B. Hillsdale	IIe	IIe	95	170	16	27	35	55	4.0	8.0	55	40
10C. Hillsdale	IIIe	IIIe	80	165	15	25	32	50	3.6	7.5	45	35
10D. Hillsdale	IVe	---	70	---	11	---	30	---	3.2	---	40	32
12A. Brady	IIw	---	105	---	16	---	32	---	4.0	---	90	50
13. Granby	IVw	---	75	---	10	---	30	---	---	---	55	35
14. Sebewa	IIw	---	105	---	17	---	36	---	4.6	---	90	50
15. Cohoctah	Vw	---	---	---	---	---	---	---	3.0	---	---	---
16B. Elmdale	IIe	IIe	85	170	14	25	25	55	3.7	8.0	60	40
17B. Teasdale	IIw	---	105	---	17	---	33	---	4.8	---	90	50
18. Barry	IIw	---	110	---	17	---	35	---	---	---	95	55
19. Houghton	IIIw	---	115	---	20	---	34	---	---	---	---	---
20A. Bronson	IIs	IIs	75	170	13	27	28	55	3.0	8.0	60	35

TABLE 5.--CAPABILITY AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Capability subclass		Corn		Corn silage		Soybeans		Legume hay		Oats	Winter wheat
	N	I	N	I	N	I	N	I	N	I	N	N
			Bu	Bu	Ton	Ton	Bu	Bu	Ton	Ton	Bu	Bu
21A--------------- Matherton	IIw	---	105	---	17	---	36	---	---	---	80	45
24---------------- Adrian	IVw	---	75	---	10	---	23	---	---	---	---	---
25*. Pits												
26---------------- Palms	Vw	---	---	---	---	---	---	---	---	---	---	---
27B--------------- Kalamazoo	IIe	IIs	95	175	16	27	30	55	3.8	4.0	75	40
27C--------------- Kalamazoo	IIIe	IIe	70	170	14	25	27	50	3.2	4.0	70	38
28B--------------- Riddles	IIe	---	100	170	18	27	32	---	3.8	---	---	46
28C--------------- Riddles	IVe	---	90	---	16	---	30	---	3.4	---	---	42
29B--------------- Schoolcraft	IIe	IIe	85	180	14	28	28	55	3.8	9.0	80	45
30B. Urban land- Oshtemo												
31B*. Udorthents												
32*. Dumps												
33A. Urban land- Elston												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[All soils are assigned to nonirrigated capability subclasses (N). Only potentially irrigable soils are assigned to irrigated subclasses (I). Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)			
		Erosion (e)	Wetness (w)	Soil problem (s)	Climate (c)
		Acres	Acres	Acres	Acres
I (N)	---	---	---	---	---
(I)	---	---	---	---	---
II (N)	83,250	42,065	23,315	17,870	---
(I)	59,935	42,065	---	17,870	---
III (N)	177,610	27,870	15,155	134,585	---
(I)	162,455	27,870	---	134,585	---
IV (N)	39,020	21,655	17,365	---	---
(I)	---	---	---	---	---
V (N)	6,320	---	6,320	---	---
VI (N)	---	---	---	---	---
VII (N)	---	---	---	---	---
VIII(N)	5,790	---	5,790	---	---

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordi-nation symbol	Management concerns: Erosion hazard	Management concerns: Equip-ment limita-tion	Management concerns: Seedling mortal-ity	Management concerns: Wind-throw hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
4B, 4C, 4D--------- Oshtemo	2o	Slight	Slight	Slight	Slight	Northern red oak---- White oak----------- American basswood--- Sugar maple----------	66 --- 66 61	Eastern white pine, red pine, white spruce, Norway spruce, Carolina poplar.
5B, 5C, 5D--------- Spinks	2s	Slight	Slight	Moderate	Slight	Northern red oak---- White oak----------- Black oak----------- Black cherry--------	66 --- --- ---	Red pine, eastern white pine, Carolina poplar.
8A----------------- Nottawa	---	--------	--------	--------	--------	-------------------	---	Red pine, eastern white pine, Carolina poplar.
9A----------------- Elston	---	--------	--------	--------	--------	-------------------	---	Red pine, eastern white pine, Carolina poplar.
10B, 10C, 10D------ Hillsdale	2o	Slight	Slight	Slight	Slight	Northern red oak---- White ash----------- Sugar maple--------- Black cherry-------- American basswood--- Yellow-poplar-------	66 --- --- --- --- ---	Black walnut, eastern white pine, white spruce, red pine, yellow-poplar, Carolina poplar.
12A---------------- Brady	3o	Slight	Slight	Slight	Slight	Red maple----------- White ash----------- Quaking aspen------- Silver maple-------- Bitternut hickory--- Swamp white oak----- American basswood---	56 --- --- --- --- --- 56	Carolina poplar, Norway spruce, eastern white pine.
13----------------- Granby	5w	Slight	Severe	Severe	Severe	Red maple----------- Silver maple-------- American basswood--- Pin oak------------- Quaking aspen------- Eastern cottonwood-- White ash-----------	40 --- --- --- --- --- ---	Eastern white pine, Norway spruce, white spruce.
14----------------- Sebewa	2w	Slight	Severe	Moderate	Moderate	Red maple----------- White ash----------- American basswood--- Swamp white oak----- Pin oak------------- Northern red oak----	66 --- --- --- --- ---	White spruce, eastern white pine, Norway spruce, white ash.
15----------------- Cohoctah	3w	Slight	Severe	Severe	Moderate	Red maple----------- Eastern cottonwood-- Silver maple-------- White ash----------- Swamp white oak----- American sycamore---	56 --- --- --- --- ---	
16B---------------- Elmdale	1o	Slight	Slight	Slight	Slight	Northern red oak---- White oak----------- Black walnut-------- Black cherry-------- Yellow-poplar------- Sugar maple--------- American basswood--- White ash-----------	70+ --- --- --- --- --- --- ---	Black walnut, yellow-poplar.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
17B: Teasdale	2o	Slight	Slight	Slight	Slight	Northern red oak	66	White spruce, eastern white pine, Norway spruce, Carolina poplar.
						Red maple	---	
						White ash	---	
						Eastern cottonwood	---	
						American basswood	---	
						Northern pin oak	---	
18: Barry	3w	Slight	Severe	Severe	Severe	Red maple	56	
						White ash	---	
						Eastern cottonwood	---	
						Silver maple	---	
						Swamp white oak	---	
						American sycamore	---	
						Bitternut hickory	---	
						Pin oak	---	
19: Houghton	3w	Slight	Severe	Severe	Severe	Red maple	56	
						Silver maple	---	
						White ash	---	
						Quaking aspen	---	
						Tamarack	---	
						Green ash	---	
20A: Bronson	2o	Slight	Slight	Slight	Slight	Northern red oak	66	Eastern white pine, red pine, Carolina poplar, black walnut.
						White oak	66	
						Sugar maple	61	
						American beech	---	
						American basswood	---	
						Shagbark hickory	---	
						Black walnut	---	
21A: Matherton	2o	Slight	Slight	Slight	Slight	Northern red oak	66	White spruce, Norway spruce, eastern white pine, Carolina poplar.
						Swamp white oak	---	
						White oak	---	
						White ash	---	
						American basswood	---	
						Red maple	---	
24: Adrian	3w	Slight	Severe	Severe	Severe	Red maple	56	
						Silver maple	---	
						White ash	---	
						Quaking aspen	---	
						Tamarack	---	
						Green ash	---	
26: Palms	3w	Slight	Severe	Severe	Severe	Red maple	56	
						Silver maple	---	
						White ash	---	
						Quaking aspen	---	
						Black ash	---	
						Tamarack	---	
27B, 27C: Kalamazoo	2o	Slight	Slight	Slight	Slight	Northern red oak	65	Black walnut, yellow-poplar, eastern white pine, white spruce, Norway spruce, red pine, Carolina poplar.
						White ash	---	
						Black walnut	---	
						Yellow-poplar	---	
						White oak	---	
						Black cherry	---	
						American basswood	65	
						Sugar maple	61	
28B, 28C: Riddles	1o	Slight	Slight	Slight	Slight	Northern red oak	75	Black walnut, red pine, white spruce.
						Red maple	---	
						White ash	---	
						Green ash	---	
						Black walnut	---	
						Yellow-poplar	---	

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
29B----------------- Schoolcraft	---	---------	---------	---------	--------	--------------------	---	Black walnut, yellow-poplar, eastern white pine, white spruce, Norway spruce, red pine, Carolina poplar.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
2*: Histosols.					
Aquents.					
4B, 4C, 4D Oshtemo	---	Amur privet, autumn-olive, Tatarian honeysuckle, silky dogwood, Siberian crabapple, nannyberry viburnum.	White spruce	Eastern white pine, red pine, Norway spruce.	Carolina poplar.
5B, 5C, 5D Spinks	Vanhoutte spirea	Tatarian honeysuckle, Amur privet, autumn-olive, Siberian peashrub, sargent crabapple.	White spruce, eastern redcedar.	Eastern white pine, red pine.	Carolina poplar.
8A Nottawa	---	Tatarian honeysuckle, autumn-olive, lilac, Amur privet, silky dogwood, sargent crabapple.	---	Norway spruce, red pine, eastern white pine, eastern redcedar.	Carolina poplar.
9A Elston	---	Eastern redcedar, Amur honeysuckle, Amur privet, American cranberrybush, Washington hawthorn, Tatarian honeysuckle.	White spruce, northern white-cedar.	Eastern white pine, Norway spruce, red pine.	Carolina poplar.
10B, 10C, 10D Hillsdale	---	Tatarian honeysuckle, lilac, Siberian crabapple, Amur privet, autumn-olive.	White spruce	Eastern white pine, red pine, Norway spruce.	Carolina poplar.
12A Brady	---	White spruce, silky dogwood, Tatarian honeysuckle, Amur privet, American cranberrybush.	Northern white-cedar.	Norway spruce, eastern white pine, golden willow, green ash.	Carolina poplar.
13 Granby	Silky dogwood, American cranberrybush.	Northern white-cedar, Amur privet, white spruce, Tatarian honeysuckle.	Eastern white pine, Norway spruce, Manchurian crabapple, green ash, golden willow.	---	Carolina poplar.
14 Sebewa	---	Silky dogwood, Amur privet, Tatarian honeysuckle.	White spruce, northern white-cedar, Manchurian crabapple.	Eastern white pine, Norway spruce.	Carolina poplar, golden willow.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
15. Cohoctah					
16B----------------Elmdale	Silky dogwood-----	Lilac, autumn-olive, Tatarian honeysuckle, Amur privet.	Red pine, white spruce.	Green ash, eastern white pine, Norway spruce.	Carolina poplar.
17B----------------Teasdale	---	American cranberrybush, Amur privet, silky dogwood, Tatarian honeysuckle, nannyberry viburnum.	White spruce, northern white-cedar, Manchurian crabapple.	Eastern white pine, Norway spruce.	Carolina poplar, golden willow.
18----------------Barry	Vanhoutte spirea	Silky dogwood, American cranberrybush, white spruce, Amur privet.	Manchurian crabapple, northern white-cedar.	Norway spruce, green ash, golden willow.	Carolina poplar.
19----------------Houghton	Vanhoutte spirea	Silky dogwood, Amur privet, white spruce.	Northern white-cedar, Manchurian crabapple.	Eastern white pine, Norway spruce.	Carolina poplar.
20A----------------Bronson	---	Amur privet, Tatarian honeysuckle, silky dogwood, lilac, Siberian crabapple, autumn-olive.	White spruce, northern white-cedar.	Eastern white pine, red pine, Norway spruce.	Carolina poplar.
21A----------------Matherton	Vanhoutte spirea	Silky dogwood, Tatarian honeysuckle, Amur privet, American cranberrybush.	Northern white-cedar, white spruce, Manchurian crabapple.	Eastern white pine, Norway spruce.	Carolina poplar, golden willow.
24----------------Adrian	---	Silky dogwood, American cranberrybush, white spruce, Tatarian honeysuckle, Amur privet.	Northern white-cedar, Manchurian crabapple.	Norway spruce, golden willow, eastern white pine, green ash.	Carolina poplar.
25*. Pits					
26. Palms					
27B, 27C----------Kalamazoo	---	Lilac, Amur privet, Tatarian honeysuckle, silky dogwood, nannyberry viburnum, autumn-olive.	White spruce------	Red pine, eastern white pine, Norway spruce.	Carolina poplar.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
28B, 28C: Riddles	---	Amur privet, Amur honeysuckle, American cranberrybush, Washington hawthorn, Tatarian honeysuckle.	Eastern redcedar, northern white-cedar.	Eastern white pine, Norway spruce, red pine.	Carolina poplar.
29B: Schoolcraft	---	Lilac, Amur privet, sargent crabapple, Tatarian honeysuckle, autumn-olive, silky dogwood.	White spruce	Red pine, Norway spruce, eastern white pine.	Carolina poplar.
30B*: Urban land.					
Oshtemo	---	Amur privet, autumn-olive, Tatarian honeysuckle, silky dogwood, Siberian crabapple, nannyberry viburnum.	White spruce	Eastern white pine, red pine, Norway spruce.	Carolina poplar.
31B*. Udorthents					
32*. Dumps					
33A*: Urban land.					
Elston	---	Eastern redcedar, Amur honeysuckle, Amur privet, American cranberrybush, Washington hawthorn, Tatarian honeysuckle.	White spruce, northern white-cedar.	Eastern white pine, Norway spruce, red pine.	Carolina poplar.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
2*:					
Histosols.					
Aquents.					
4B Oshtemo	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight	Moderate: small stones.
4C Oshtemo	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight	Moderate: small stones, slope.
4D Oshtemo	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.	Severe: slope.
5B Spinks	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
5C Spinks	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
5D Spinks	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
8A Nottawa	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
9A Elston	Slight	Slight	Slight	Slight	Slight.
10B Hillsdale	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
10C Hillsdale	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
10D Hillsdale	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
12A Brady	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
13 Granby	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
14 Sebewa	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
15 Cohoctah	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: flooding, wetness.
16B Elmdale	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Slight	Moderate: large stones.
17B Teasdale	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
18 Barry	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
19 Houghton	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.
20A Bronson	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
21A Matherton	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
24 Adrian	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.
25*. Pits					
26 Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
27B Kalamazoo	Slight	Slight	Moderate: small stones.	Slight	Slight.
27C Kalamazoo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
28B Riddles	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
28C Riddles	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
29B Schoolcraft	Slight	Slight	Moderate: slope.	Slight	Slight.
30B*: Urban land.					
Oshtemo	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight	Moderate: small stones.
31B*. Udorthents					
32*. Dumps					
33A*: Urban land.					
Elston	Slight	Slight	Slight	Slight	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
2*:										
Histosols.										
Aquents.										
4B Oshtemo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
4C Oshtemo	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
4D Oshtemo	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
5B Spinks	Poor	Fair	Good	Fair	Fair	Poor	Very poor.	Fair	Fair	Very poor.
5C, 5D Spinks	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
8A Nottawa	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
9A Elston	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
10B Hillsdale	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
10C Hillsdale	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
10D Hillsdale	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
12A Brady	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
13 Granby	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
14 Sebewa	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
15 Cohoctah	Poor	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
16B Elmdale	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
17B Teasdale	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
18 Barry	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
19 Houghton	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
20A Bronson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
21A------------------ Matherton	Good	Good	Good	Good	Fair	Fair	Fair	Good	Good	Fair.
24------------------- Adrian	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
25*. Pits										
26------------------- Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
27B------------------ Kalamazoo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
27C------------------ Kalamazoo	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
28B------------------ Riddles	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
28C------------------ Riddles	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
29B------------------ Schoolcraft	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
30B*: Urban land.										
Oshtemo--------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
31B*. Udorthents										
32*. Dumps										
33A*: Urban land.										
Elston---------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
2*:						
Histosols.						
Aquents.						
4B Oshtemo	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: small stones
4C Oshtemo	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones slope.
4D Oshtemo	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
5B Spinks	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
5C Spinks	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
5D Spinks	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
8A Nottawa	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Moderate: droughty.
9A Elston	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
10B Hillsdale	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
10C Hillsdale	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
10D Hillsdale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
12A Brady	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
13 Granby	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
14 Sebewa	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: frost action, ponding.	Severe: ponding.
15 Cohoctah	Severe: wetness, cutbanks cave.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: flooding, frost action, wetness.	Severe: flooding, wetness.
16B Elmdale	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: large stone

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
17B------------------ Teasdale	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
18------------------- Barry	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
19------------------- Houghton	Severe: ponding, excess humus.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: excess humus, ponding.
20A------------------ Bronson	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
21A------------------ Matherton	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
24------------------- Adrian	Severe: ponding, cutbanks cave, excess humus.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: excess humus, ponding.
25*. Pits						
26------------------- Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
27B------------------ Kalamazoo	Severe: cutbanks cave.	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.	Slight.
27C------------------ Kalamazoo	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
28B------------------ Riddles	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Moderate: low strength, frost action.	Slight.
28C------------------ Riddles	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
29B------------------ Schoolcraft	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Moderate: frost action.	Slight.
30B*: Urban land.						
Oshtemo--------------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: small stones.
31B*. Udorthents						
32*. Dumps						

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
33A*:						
Urban land.						
Elston	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2*:					
Histosols.					
Aquents.					
4B------------------ Oshtemo	Slight------------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
4C------------------ Oshtemo	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
4D------------------ Oshtemo	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: seepage, slope.
5B------------------ Spinks	Slight------------	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
5C------------------ Spinks	Moderate: slope.	Severe: seepage, slope.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
5D------------------ Spinks	Severe: slope.	Severe: seepage, slope.	Severe: slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
8A------------------ Nottawa	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
9A------------------ Elston	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
10B----------------- Hillsdale	Slight------------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
10C----------------- Hillsdale	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
10D----------------- Hillsdale	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
12A----------------- Brady	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: wetness.
13------------------ Granby	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
14------------------ Sebewa	Severe: poor filter, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: small stones, seepage, too sandy.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
15 Cohoctah	Severe: wetness, flooding, poor filter.	Severe: wetness, flooding, seepage.	Severe: wetness, flooding, seepage.	Severe: wetness, flooding, seepage.	Poor: wetness, thin layer.
16B Elmdale	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
17B Teasdale	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: wetness.
18 Barry	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
19 Houghton	Severe: ponding, percs slowly.	Severe: seepage, ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
20A Bronson	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage.
21A Matherton	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
24 Adrian	Severe: ponding, poor filter.	Severe: seepage, ponding, excess humus.	Severe: ponding, seepage.	Severe: ponding, seepage.	Poor: ponding, excess humus.
25*. Pits					
26 Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
27B Kalamazoo	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Slight	Poor: thin layer.
27C Kalamazoo	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage.	Slight	Poor: thin layer.
28B Riddles	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
28C Riddles	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
29B Schoolcraft	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
30B*: Urban land.					
Oshtemo	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
31B*. Udorthents					
32*. Dumps					
33A*: Urban land.					
Elston	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2*: Histosols.				
Aquents.				
4B, 4C----------------- Oshtemo	Good	Probable	Probable	Poor: small stones.
4D------------------- Oshtemo	Fair: slope.	Probable	Probable	Poor: small stones, slope.
5B------------------- Spinks	Good	Probable	Improbable: too sandy.	Fair: too sandy.
5C------------------- Spinks	Good	Probable	Improbable: too sandy.	Fair: slope, too sandy.
5D------------------- Spinks	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
8A------------------- Nottawa	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
9A------------------- Elston	Good	Probable	Improbable: too sandy.	Fair: thin layer.
10B------------------ Hillsdale	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
10C------------------ Hillsdale	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
10D------------------ Hillsdale	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
12A------------------ Brady	Fair: wetness.	Probable	Probable	Poor: small stones.
13------------------- Granby	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
14------------------- Sebewa	Poor: wetness.	Probable	Probable	Poor: wetness, small stones, area reclaim.
15------------------- Cohoctah	Poor: wetness.	Probable	Probable	Poor: wetness, area reclaim.
16B------------------ Elmdale	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
17B------------------ Teasdale	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
18------------------- Barry	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
19 Houghton	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: wetness, excess humus.
20A Bronson	Fair: wetness.	Probable	Probable	Poor: small stones.
21A Matherton	Fair: wetness.	Probable	Probable	Fair: too clayey, small stones.
24 Adrian	Poor: wetness, low strength.	Probable	Improbable: too sandy.	Poor: wetness, excess humus.
25*. Pits				
26 Palms	Poor: wetness.	Improbable: excess humus, excess fines.	Improbable: excess humus, excess fines.	Poor: wetness, excess humus.
27B, 27C Kalamazoo	Good	Probable	Probable	Poor: area reclaim, small stones.
28B Riddles	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
28C Riddles	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
29B Schoolcraft	Good	Probable	Improbable: too sandy.	Poor: area reclaim.
30B*: Urban land.				
Oshtemo	Good	Probable	Probable	Poor: small stones.
31B*. Udorthents				
32*. Dumps				
33A*: Urban land.				
Elston	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
2*: Histosols.						
Aquents.						
4B---------------- Oshtemo	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Soil blowing, slope.	Favorable.
4C, 4D------------ Oshtemo	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Soil blowing, slope.	Slope.
5B---------------- Spinks	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
5C, 5D------------ Spinks	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
8A---------------- Nottawa	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, soil blowing.	Droughty.
9A---------------- Elston	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Soil blowing---	Favorable.
10B--------------- Hillsdale	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing, slope.	Favorable.
10C, 10D---------- Hillsdale	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing, slope.	Slope.
12A--------------- Brady	Severe: seepage.	Severe: piping, wetness.	Severe: cutbanks cave.	Frost action---	Wetness, soil blowing.	Wetness.
13---------------- Granby	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty.	Wetness, droughty.
14---------------- Sebewa	Severe: seepage.	Severe: seepage, ponding.	Severe: cutbanks cave.	Frost action, cutbanks cave, ponding.	Ponding--------	Wetness.
15---------------- Cohoctah	Severe: seepage.	Severe: piping, wetness.	Severe: cutbanks cave.	Flooding, frost action.	Wetness, soil blowing.	Wetness.
16B--------------- Elmdale	Moderate: seepage, slope.	Severe: piping.	Moderate: deep to water, slow refill.	Slope----------	Wetness, soil blowing, slope.	Favorable.
17B--------------- Teasdale	Moderate: seepage.	Severe: piping, wetness.	Severe: cutbanks cave.	Frost action---	Wetness, soil blowing.	Wetness.
18---------------- Barry	Severe: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Ponding--------	Wetness.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
19---------------- Houghton	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Frost action, subsides, ponding.	Soil blowing, ponding.	Wetness.
20A--------------- Bronson	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, soil blowing.	Favorable.
21A--------------- Matherton	Severe: seepage.	Severe: seepage, wetness.	Moderate: slow refill, cutbanks cave.	Frost action, cutbanks cave.	Wetness---------	Wetness.
24---------------- Adrian	Severe: seepage.	Severe: seepage, ponding, excess humus.	Severe: slow refill, cutbanks cave.	Ponding, frost action, subsides.	Ponding, soil blowing.	Wetness.
25*. Pits						
26---------------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides.	Ponding, soil blowing.	Wetness.
27B--------------- Kalamazoo	Severe: seepage.	Severe: thin layer.	Severe: no water.	Deep to water	Favorable------	Favorable.
27C--------------- Kalamazoo	Severe: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope-----------	Slope.
28B--------------- Riddles	Moderate: seepage, slope.	Slight---------	Severe: no water.	Deep to water	Slope, soil blowing.	Favorable.
28C--------------- Riddles	Severe: slope.	Slight---------	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
29B--------------- Schoolcraft	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
30B*: Urban land.						
Oshtemo-----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Soil blowing, slope.	Favorable.
31B*. Udorthents						
32*. Dumps						
33A*: Urban land.						
Elston------------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Soil blowing---	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
2*: Histosols.											
Aquents.											
4B, 4C, 4D Oshtemo	0-14	Sandy loam	SM, SM-SC	A-2, A-4	0	95-100	60-95	60-70	25-40	15-25	2-7
	14-35	Sandy loam, sandy clay loam, gravelly sandy loam.	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	60-95	60-85	25-45	12-30	2-16
	35-60	Loamy sand, sandy loam.	SM, SP-SM	A-2	0	85-95	60-95	55-70	10-30	---	NP
	60-66	Stratified coarse sand to gravel.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0-5	40-90	35-85	20-60	0-10	---	NP
5B, 5C, 5D Spinks	0-10	Loamy sand	SM	A-2-4	0	100	80-100	50-90	15-30	---	NP
	10-26	Loamy sand	SM	A-2-4	0	100	80-100	50-90	15-25	---	NP
	26-60	Stratified fine sand to loamy fine sand.	SM, SP-SM	A-2-4	0	100	80-100	60-90	10-30	---	NP
8A Nottawa	0-11	Sandy loam	SM, SM-SC	A-2, A-4	0	95-100	80-100	60-70	30-40	<20	NP-6
	11-28	Sandy loam, loam, loamy sand.	SM, SC	A-4	0	95-100	80-100	50-80	35-65	<25	NP-10
	28-46	Sand, loamy sand	SM, SP-SM, SM-SC	A-1, A-2, A-3	0	95-100	80-100	40-75	5-30	<20	NP-4
	46-60	Sand	SM, SP-SM	A-1, A-2, A-3	0-3	90-100	80-100	40-70	5-25	---	NP
9A Elston	0-10	Sandy loam	SM	A-2, A-4	0	100	100	60-70	30-40	<30	NP-6
	10-28	Sandy loam, loam, sandy clay loam.	SM, CL, SC, ML	A-4, A-6	0	95-100	75-95	50-80	35-65	<30	NP-15
	28-39	Loamy sand, sandy loam.	SP-SM, SM, SC, SM-SC	A-2-4, A-3, A-1-b	0-3	95-100	75-95	45-75	5-30	<25	NP-10
	39-60	Sand	SP-SM, SM	A-3, A-2-4, A-1-b	0-3	95-100	70-95	40-70	5-25	---	NP
10B, 10C, 10D Hillsdale	0-10	Sandy loam	SM, SC, ML, CL	A-2-4, A-4	0-5	95-100	80-100	60-90	20-65	<25	2-10
	10-45	Sandy loam, sandy clay loam, loam.	SM, SC, SM-SC	A-2-4, A-2-6, A-4, A-6	0-5	95-100	80-100	65-85	30-50	20-30	2-12
	45-60	Sandy loam, loamy sand.	SM, SC, SM-SC	A-2-4, A-4	0-5	95-100	80-100	55-80	25-40	<22	3-8
12A Brady	0-9	Sandy loam	SM, SM-SC	A-2, A-4	0-5	95-100	75-100	60-70	25-40	<25	NP-7
	9-24	Sandy loam, sandy clay loam.	SM, SC, SM-SC	A-2, A-4, A-6	0-5	95-100	75-95	60-80	25-45	15-35	NP-16
	24-55	Loamy sand, sandy loam.	SM	A-2	0-5	95-100	75-95	55-70	15-35	---	NP
	55-60	Stratified sand to gravel.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2-4	0-5	40-75	35-70	20-55	0-10	---	NP
13 Granby	0-11	Sandy loam	SM	A-2	0	100	100	60-70	20-35	---	NP
	11-28	Sand, sandy loam, loamy sand.	SP, SP-SM, SM	A-3, A-2	0	100	95-100	50-75	0-20	---	NP
	28-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-70	0-5	---	NP
14 Sebewa	0-13	Loam	CL, CL-ML	A-4, A-6	0	95-100	80-100	75-95	50-90	22-35	6-12
	13-28	Sandy clay loam, loam, gravelly clay loam.	SC, CL	A-4, A-6	0	95-100	65-95	55-85	40-75	25-40	8-20
	28-60	Gravelly sand	SP, SP-SM, GP, GP-GM	A-1	0-5	40-75	35-70	20-40	0-10	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
15 Cohoctah	0-6	Loam	ML, SM	A-4, A-2	0	100	100	65-95	30-75	20-30	NP-6
	6-30	Loam, fine sandy loam, sandy loam.	ML, SM, CL, SC	A-4, A-2	0	100	100	70-90	30-70	20-30	NP-10
	30-60	Sand, gravelly coarse sand, gravelly sand.	SP-SM, SP, GP, GP-GM	A-1, A-3, A-2-4	0-10	40-90	35-85	30-60	0-10	---	NP
16B Elmdale	0-10	Sandy loam	SM, SM-SC	A-2-4, A-4, A-1-b	0-10	90-100	85-100	45-70	15-40	<25	2-7
	10-47	Sandy loam, loam, sandy clay loam.	SM, CL, SC, ML	A-2, A-4, A-6	0-10	90-100	85-100	55-95	25-70	14-30	2-18
	47-60	Sandy loam	SM, SM-SC, SC	A-2-4, A-4	0-5	95-100	95-100	50-70	20-40	<25	NP-8
17B Teasdale	0-13	Sandy loam	SM, SM-SC, SC	A-2-4, A-4	0-5	95-100	95-100	55-95	25-50	<25	2-8
	13-26	Sandy loam, loam, sandy clay loam.	ML, CL, SM, SC	A-2-4, A-2-6, A-4, A-6	0-8	85-100	80-100	50-85	25-70	20-35	2-15
	26-60	Sandy loam, loamy sand, fine sandy loam.	SM, SM-SC, SC	A-2-4, A-4	0-5	85-100	85-100	55-70	15-40	<25	NP-8
18 Barry	0-10	Loam	ML, CL, CL-ML	A-4	0-3	95-100	90-100	80-100	55-90	20-30	NP-8
	10-29	Loam, sandy clay loam, clay loam.	SC, CL, CL-ML, SM-SC	A-4, A-6	0-3	95-100	90-100	80-90	45-75	18-28	4-14
	29-60	Sandy loam	SM, SM-SC	A-2, A-4	0-3	95-100	90-100	35-70	30-40	<20	NP-5
19 Houghton	0-60	Sapric material	Pt	A-8	0	---	---	---	---	---	---
20A Bronson	0-10	Sandy loam	SM, SM-SC	A-2, A-4	0-5	95-100	90-100	65-75	20-40	<25	NP-5
	10-26	Sandy loam, sandy clay loam.	SM, SC, SM-SC	A-2, A-4, A-6	0-5	95-100	60-95	60-85	25-45	<30	NP-15
	26-34	Loamy sand, gravelly loamy sand.	SM, SP-SM	A-2	0-5	85-95	60-95	55-70	10-15	---	NP
	34-60	Sand and gravel	SP, GP, SP-SM, GP-GM	A-1, A-2, A-3	0-10	40-90	35-85	20-60	0-10	---	NP
21A Matherton	0-11	Loam	ML, CL, CL-ML	A-4	0-5	90-100	80-100	80-95	50-90	20-30	NP-8
	11-32	Sandy clay loam, clay loam, loam.	SC, CL, CL-ML, SM-SC	A-6, A-4	0-5	90-100	65-95	50-85	35-70	25-40	5-20
	32-70	Gravelly sand, sand, loamy sand	GP, SP, SP-SM, GP-GM	A-1, A-3, A-2-4	0-10	40-100	35-90	30-55	0-10	---	NP
24 Adrian	0-32	Sapric material	Pt	A-8	---	---	---	---	---	---	---
	32-60	Sand, loamy sand, fine sand.	SP, SM	A-2, A-3, A-1	0	80-100	60-100	35-75	0-30	---	NP
25*. Pits											
26 Palms	0-21	Sapric material	Pt	---	---	---	---	---	---	---	---
	21-60	Clay loam, silty clay loam, sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas tici inde
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
27B, 27C---------- Kalamazoo	0-12	Loam--------------	ML, CL-ML, CL	A-4	0-5	95-100	80-100	80-90	55-70	<25	NP-1
	12-28	Clay loam, sandy clay loam, sandy loam.	SC, CL	A-4, A-6	0-5	95-100	85-95	65-95	35-80	20-38	9-2
	28-76	Loamy coarse sand, loamy sand, gravelly loamy coarse sand.	SM, SP-SM	A-2-4, A-1-b	0-5	95-100	80-95	40-60	10-25	---	NP
28B, 28C---------- Riddles	0-9	Sandy loam--------	SM, SC, SM-SC	A-2-4, A-4	0	95-100	85-95	50-70	25-40	20-30	2-1
	9-55	Sandy loam, clay loam, loam.	CL, SC	A-6	0	90-100	80-95	75-90	35-75	25-40	10-2
	55-60	Clay loam, sandy loam, loam.	CL, SM, SC, ML	A-4, A-6, A-2	0-3	85-95	80-90	50-90	30-70	15-30	2-1
29B--------------- Schoolcraft	0-11	Loam--------------	ML, CL-ML	A-4	0	95-100	90-100	80-90	60-70	20-35	2-9
	11-23	Clay loam, loam, sandy clay loam.	CL, SC	A-4, A-6	0	85-100	70-100	70-95	35-75	25-38	9-1
	23-31	Sandy loam--------	SM, SM-SC	A-1, A-2	0	80-100	70-95	35-60	15-30	12-23	NP-7
	31-75	Sand, gravelly sand, loamy sand	SP, SP-SM	A-1, A-2, A-3	0	75-100	70-95	35-65	0-10	---	NP
30B*: Urban land.											
Oshtemo-----------	0-14	Sandy loam--------	SM, SM-SC	A-2, A-4	0	95-100	60-95	60-70	25-40	15-25	2-7
	14-35	Sandy loam, sandy clay loam, gravelly sandy loam.	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	60-95	60-85	25-45	12-30	2-1
	35-60	Loamy sand, sandy loam.	SM, SP-SM	A-2	0	85-95	60-95	55-70	10-30	---	NP
	60-66	Stratified coarse sand to gravel.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0-5	40-90	35-85	20-60	0-10	---	NP
31B*. Udorthents											
32*. Dumps											
33A*: Urban land.											
Elston------------	0-10	Sandy loam--------	SM	A-2, A-4	0	100	100	60-70	30-40	<30	NP-
	10-28	Sandy loam, loam, sandy clay loam.	SM, CL, SC, ML	A-4, A-6	0	95-100	75-95	50-80	35-65	<30	NP-
	28-39	Loamy sand, sandy loam.	SP-SM, SM, SC, SM-SC	A-2-4, A-3, A-1-b	0-3	95-100	75-95	45-75	5-30	<25	NP-
	39-60	Sand--------------	SP-SM, SM	A-3, A-2-4, A-1-b	0-3	95-100	70-95	40-70	5-25	---	NP

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
2*:											
Histosols.											
Aquents.											
4B, 4C, 4D-------	0-14	2-10	1.20-1.60	2.0-6.0	0.10-0.15	5.1-6.5	Low-----------	0.24	5	3	.5-3
Oshtemo	14-35	10-18	1.20-1.60	2.0-6.0	0.12-0.19	5.1-6.5	Low-----------	0.24			
	35-60	5-15	1.20-1.60	2.0-20	0.06-0.10	5.1-7.3	Low-----------	0.17			
	60-66	0-15	1.20-1.50	>20	0.02-0.04	7.4-8.4	Low-----------	0.10			
5B, 5C, 5D-------	0-10	2-15	1.20-1.60	6.0-20	0.08-0.10	5.1-7.3	Low-----------	0.17	5	2	2-4
Spinks	10-26	3-15	1.20-1.60	2.0-6.0	0.06-0.10	5.6-7.3	Low-----------	0.17			
	26-60	0-15	1.20-1.50	2.0-6.0	0.04-0.08	5.6-7.8	Low-----------	0.17			
8A---------------	0-11	2-12	1.10-1.65	2.0-6.0	0.10-0.15	5.1-7.3	Low-----------	0.20	4	3	1-3
Nottawa	11-28	12-18	1.25-1.70	2.0-6.0	0.10-0.20	4.5-6.0	Low-----------	0.20			
	28-46	0-10	1.25-1.70	6.0-20	0.05-0.11	4.5-6.5	Low-----------	0.20			
	46-60	0-5	1.45-1.70	6.0-20	0.04-0.07	6.1-8.4	Low-----------	0.15			
9A---------------	0-10	8-18	1.35-1.55	2.0-6.0	0.12-0.15	5.6-6.0	Low-----------	0.20	4	3	1-5
Elston	10-28	10-23	1.35-1.60	2.0-6.0	0.12-0.18	4.5-6.0	Low-----------	0.20			
	28-39	4-10	1.45-1.65	2.0-6.0	0.08-0.13	5.6-6.0	Low-----------	0.20			
	39-60	1-5	1.60-1.75	6.0-20	0.05-0.07	7.4-8.4	Low-----------	0.15			
10B, 10C, 10D----	0-10	2-15	1.10-1.60	0.6-6.0	0.13-0.22	5.1-6.5	Low-----------	0.24	5	3	1-3
Hillsdale	10-45	10-18	1.25-1.70	0.6-6.0	0.12-0.18	4.5-6.5	Low-----------	0.24			
	45-60	0-15	1.30-1.95	2.0-6.0	0.08-0.13	7.9-8.4	Low-----------	0.24			
12A--------------	0-9	2-15	1.25-1.40	2.0-6.0	0.12-0.15	5.6-7.3	Low-----------	0.20	5	3	1-4
Brady	9-24	5-22	1.35-1.45	2.0-6.0	0.12-0.17	5.1-6.5	Low-----------	0.20			
	24-55	5-20	1.25-1.50	2.0-6.0	0.08-0.10	5.1-6.5	Low-----------	0.20			
	55-60	0-10	1.25-1.50	>20	0.02-0.04	6.6-8.4	Low-----------	0.10			
13---------------	0-11	2-18	1.20-1.60	2.0-6.0	0.16-0.18	5.6-7.3	Low-----------	0.17	5	3	4-6
Granby	11-28	0-14	1.45-1.65	6.0-20	0.05-0.12	5.6-7.8	Low-----------	0.17			
	28-60	0-10	1.45-1.65	6.0-20	0.05-0.09	6.6-8.4	Low-----------	0.17			
14---------------	0-13	10-25	1.15-1.60	0.6-2.0	0.18-0.22	6.1-7.8	Low-----------	0.24	4	5	1-4
Sebewa	13-28	18-35	1.50-1.80	0.6-2.0	0.15-0.19	6.1-7.8	Low-----------	0.24			
	28-60	0-3	1.55-1.75	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
15---------------	0-6	5-20	1.20-1.60	2.0-6.0	0.13-0.22	6.1-7.8	Low-----------	0.28	5	3	1-4
Cohoctah	6-30	5-27	1.45-1.65	2.0-6.0	0.12-0.20	6.1-8.4	Low-----------	0.28			
	30-60	5-10	1.40-1.55	>20	0.02-0.07	7.9-8.4	Low-----------	0.10			
16B--------------	0-10	2-15	1.10-1.65	2.0-6.0	0.12-0.15	5.1-7.3	Low-----------	0.24	5	3	1-3
Elmdale	10-47	10-18	1.20-1.70	0.6-2.0	0.11-0.17	4.5-7.3	Low-----------	0.24			
	47-60	2-15	1.80-2.00	0.6-2.0	0.10-0.13	6.6-8.4	Low-----------	0.24			
17B--------------	0-13	5-15	1.25-1.75	2.0-6.0	0.12-0.15	5.1-6.5	Low-----------	0.24	5	3	2-3
Teasdale	13-26	10-18	1.40-1.85	0.6-2.0	0.11-0.17	4.5-7.3	Low-----------	0.24			
	26-60	5-15	1.70-1.95	2.0-6.0	0.08-0.15	6.6-8.4	Low-----------	0.24			
18---------------	0-10	8-18	1.60-1.75	0.6-2.0	0.20-0.22	6.1-7.8	Low-----------	0.28	5	5	4-7
Barry	10-29	18-25	1.25-1.85	0.6-2.0	0.14-0.19	6.1-7.8	Low-----------	0.28			
	29-60	5-18	1.80-2.00	2.0-6.0	0.10-0.13	7.4-8.4	Low-----------	0.28			
19---------------	0-60	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8	--------------	----	---	3	>70
Houghton											

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
20A---------------- Bronson	0-10	2-15	1.14-1.60	2.0-6.0	0.13-0.15	5.1-6.0	Low-----------	0.24	4	3	1-3
	10-26	10-20	1.26-1.59	2.0-6.0	0.12-0.18	5.1-6.0	Low-----------	0.24			
	26-34	0-10	1.26-1.59	6.0-20	0.06-0.08	5.1-7.3	Low-----------	0.17			
	34-60	0-5	1.20-1.47	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
21A---------------- Matherton	0-11	10-20	1.30-1.65	2.0-6.0	0.13-0.24	5.6-7.3	Low-----------	0.28	4	5	2-4
	11-32	20-35	1.40-1.70	0.6-2.0	0.16-0.18	5.6-7.3	Low-----------	0.28			
	32-70	0-10	1.50-1.65	>6.0	0.02-0.04	7.4-8.4	Low-----------	0.10			
24----------------- Adrian	0-32	---	0.30-0.55	0.2-6.0	0.35-0.45	5.1-7.8	--------------	----	---	3	55-75
	32-60	2-10	1.40-1.75	6.0-20	0.03-0.08	5.6-8.4	Low-----------	----			
25*. Pits											
26----------------- Palms	0-21	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	--------------	----	2	3	>75
	21-60	7-35	1.45-1.75	0.6-2.0	0.14-0.22	6.1-8.4	Low-----------	----			
27B, 27C---------- Kalamazoo	0-12	8-25	1.10-1.65	0.6-2.0	0.16-0.22	5.1-7.3	Low-----------	0.32	4	5	1-3
	12-28	18-35	1.25-1.70	0.6-2.0	0.10-0.18	5.1-7.3	Moderate------	0.32			
	28-76	2-15	1.50-1.65	6.0-20	0.02-0.08	5.1-7.8	Low-----------	0.10			
28B, 28C---------- Riddles	0-9	4-14	1.35-1.55	2.0-6.0	0.13-0.15	6.1-7.3	Low-----------	0.24	5	3	.5-2
	9-55	18-35	1.40-1.60	0.6-2.0	0.16-0.18	5.1-7.3	Moderate------	0.32			
	55-60	8-25	1.40-1.60	0.6-2.0	0.05-0.19	6.6-8.4	Low-----------	0.32			
29B---------------- Schoolcraft	0-11	12-20	1.31-1.78	0.6-2.0	0.18-0.24	5.6-7.3	Low-----------	0.28	4	5	1-3
	11-23	18-35	1.31-1.86	0.6-2.0	0.12-0.19	4.5-5.5	Moderate------	0.28			
	23-31	12-20	1.33-1.86	0.6-2.0	0.10-0.14	4.5-5.5	Low-----------	0.20			
	31-75	0-10	1.20-1.47	6.0-20	0.02-0.04	5.6-6.4	Low-----------	0.10			
30B*: Urban land.											
Oshtemo----------	0-14	2-10	1.20-1.60	2.0-6.0	0.10-0.15	5.1-6.5	Low-----------	0.24	5	3	.5-3
	14-35	10-18	1.20-1.60	2.0-6.0	0.12-0.19	5.1-6.5	Low-----------	0.24			
	35-60	5-15	1.20-1.60	2.0-20	0.06-0.10	5.1-7.3	Low-----------	0.17			
	60-66	0-15	1.20-1.50	>20	0.02-0.04	7.4-8.4	Low-----------	0.10			
31B*. Udorthents											
32*. Dumps											
33A*: Urban land.											
Elston-----------	0-10	8-18	1.35-1.55	2.0-6.0	0.12-0.15	5.6-6.0	Low-----------	0.20	4	3	1-5
	10-28	10-23	1.35-1.60	2.0-6.0	0.12-0.18	4.5-6.0	Low-----------	0.20			
	28-39	4-10	1.45-1.65	2.0-6.0	0.08-0.13	5.6-6.0	Low-----------	0.20			
	39-60	1-5	1.60-1.75	6.0-20	0.05-0.07	7.4-8.4	Low-----------	0.15			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "long" and "apparent" are explained in the text. The symbol > m
Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Subsidence	Potential frost action	
		Frequency	Duration	Months	Depth	Kind	Months	Total		U
					Ft			In		
2:										
Histosols.										
Aquents.										
4B, 4C, 4D: Oshtemo	B	None	---	---	>6.0	---	---	---	Low	L
5B, 5C, 5D: Spinks	A	None	---	---	>6.0	---	---	---	Low	L
8A: Nottawa	B	None	---	---	2.5-6.0	Apparent	Dec-Mar	---	Moderate	L
9A: Elston	B	None	---	---	>6.0	---	---	---	Low	L
10B, 10C, 10D: Hillsdale	B	None	---	---	>6.0	---	---	---	Moderate	Lo
12A: Brady	B	None	---	---	1.0-3.0	Apparent	Nov-May	---	High	Lo
13*: Granby	A/D	None	---	---	+1-1.0	Apparent	Nov-Jun	---	Moderate	Hi
14*: Sebewa	B/D	None	---	---	+1-1.0	Apparent	Sep-May	---	High	Hi
15: Cohoctah	B/D	Frequent	Long	Jan-Dec	0-1.0	Apparent	Sep-May	---	High	Hi
16B: Elmdale	B	None	---	---	2.0-3.0	Apparent	Nov-Apr	---	Moderate	Lo
17B: Teasdale	B	None	---	---	1.0-2.0	Apparent	Nov-May	---	High	Mo
18*: Barry	B/D	None	---	---	+1-1.0	Apparent	Nov-May	---	High	Hi
19*: Houghton	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	55-60	High	Hi
20A: Bronson	B	None	---	---	2.0-3.5	Apparent	Nov-May	---	High	Lo
21A: Matherton	B	None	---	---	1.0-2.0	Apparent	Nov-May	---	High	Mo

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Subsidence	Potential frost action	F
		Frequency	Duration	Months	Depth	Kind	Months	Total		Un
					Ft			In		
24*: Adrian	A/D	None	---	---	+1-1.0	Apparent	Nov-May	29-33	High	Hi
25. Pits										
26*: Palms	A/D	None	---	---	+1-1.0	Apparent	Nov-May	25-32	High	Hi
27B, 27C: Kalamazoo	B	None	---	---	>6.0	---	---	---	Moderate	Lo
28B, 28C: Riddles	B	None	---	---	>6.0	---	---	---	Moderate	Mo
29B: Schoolcraft	B	None	---	---	>6.0	---	---	---	Moderate	Lo
30B: Urban land.										
Oshtemo	B	None	---	---	>6.0	---	---	---	Low	Lo
31B. Udorthents										
32. Dumps										
33A: Urban land.										
Elston	B	None	---	---	>6.0	---	---	---	Low	Lo

* In the "High water table--Depth" column, a plus sign preceding the range in depth indicates that the water the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. numeral indicates the depth below the surface.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Adrian	Sandy or sandy-skeletal, mixed, euic, mesic Terric Medisaprists
Aquents	Sandy and loamy, mixed, mesic Haplaquents
Barry	Fine-loamy, mixed, mesic Typic Argiaquolls
Brady	Coarse-loamy, mixed, mesic Aquollic Hapludalfs
Bronson	Coarse-loamy, mixed, mesic Aquic Hapludalfs
*Cohoctah	Coarse-loamy, mixed, mesic Fluvaquentic Haplaquolls
Elmdale	Coarse-loamy, mixed, mesic Typic Hapludalfs
Elston	Coarse-loamy, mixed, mesic Typic Argiudolls
Granby	Sandy, mixed, mesic Typic Haplaquolls
Hillsdale	Coarse-loamy, mixed, mesic Typic Hapludalfs
Histosols	Euic, mesic Histosols
Houghton	Euic, mesic Typic Medisaprists
Kalamazoo	Fine-loamy, mixed, mesic Typic Hapludalfs
Matherton	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Udollic Ochraqualfs
Nottawa	Coarse-loamy, mixed, mesic Typic Argiudolls
Oshtemo	Coarse-loamy, mixed, mesic Typic Hapludalfs
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Riddles	Fine-loamy, mixed, mesic Typic Hapludalfs
Schoolcraft	Fine-loamy, mixed, mesic Typic Argiudolls
Sebewa	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Argiaquolls
Spinks	Sandy, mixed, mesic Psammentic Hapludalfs
Teasdale	Coarse-loamy, siliceous, mesic Glossaquic Hapludalfs
Udorthents	Loamy, mixed, mesic Udorthents

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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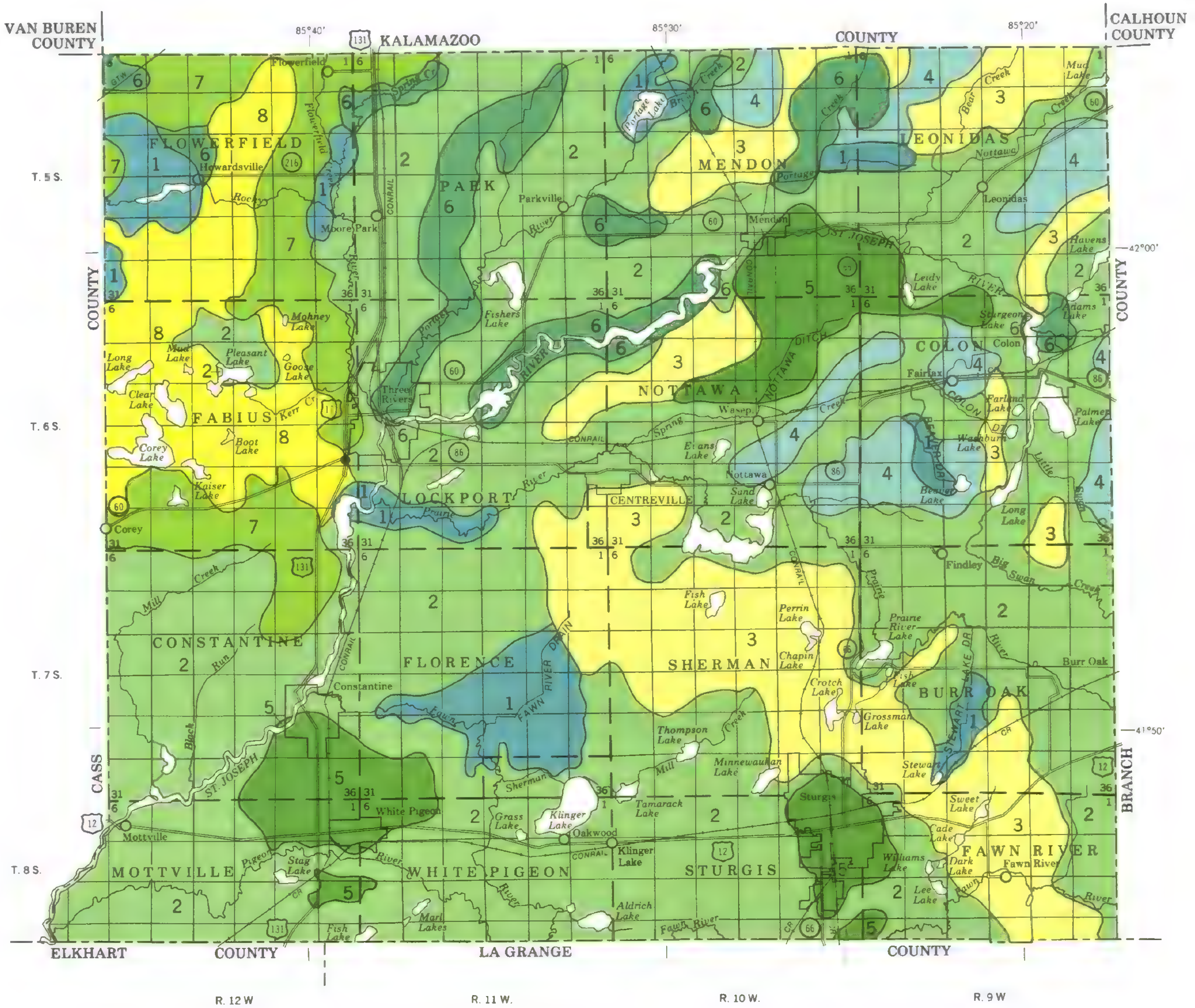
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MICHIGAN AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

ST. JOSEPH COUNTY, MICHIGAN

Scale 1:190,080



SOIL LEGEND*

1	Adrian-Granby association: Nearly level, very poorly drained and poorly drained mucky and loamy soils; in bogs and depressions and on outwash plains and lake plains
2	Oshtemo-Spinks association: Nearly level to gently rolling, well drained loamy and sandy soils; on outwash plains and moraines
3	Hillsdale-Elmdale association: Nearly level to gently rolling, well drained and moderately well drained loamy soils; on till plains and moraines
4	Elmdale-Teasdale association: Nearly level and undulating, moderately well drained and somewhat poorly drained loamy soils; on till plains and moraines
5	Elston association: Nearly level, well drained loamy soils; on outwash plains
6	Sebewa-Cohoctah association: Nearly level, very poorly drained and poorly drained loamy soils; on outwash plains and flood plains
7	Kalamazoo-Oshtemo association: Nearly level to rolling, well drained loamy soils; on outwash plains and moraines
8	Hillsdale-Riddles association: Undulating to rolling, well drained loamy soils; on till plains and moraines

*The texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

Compiled 1981

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

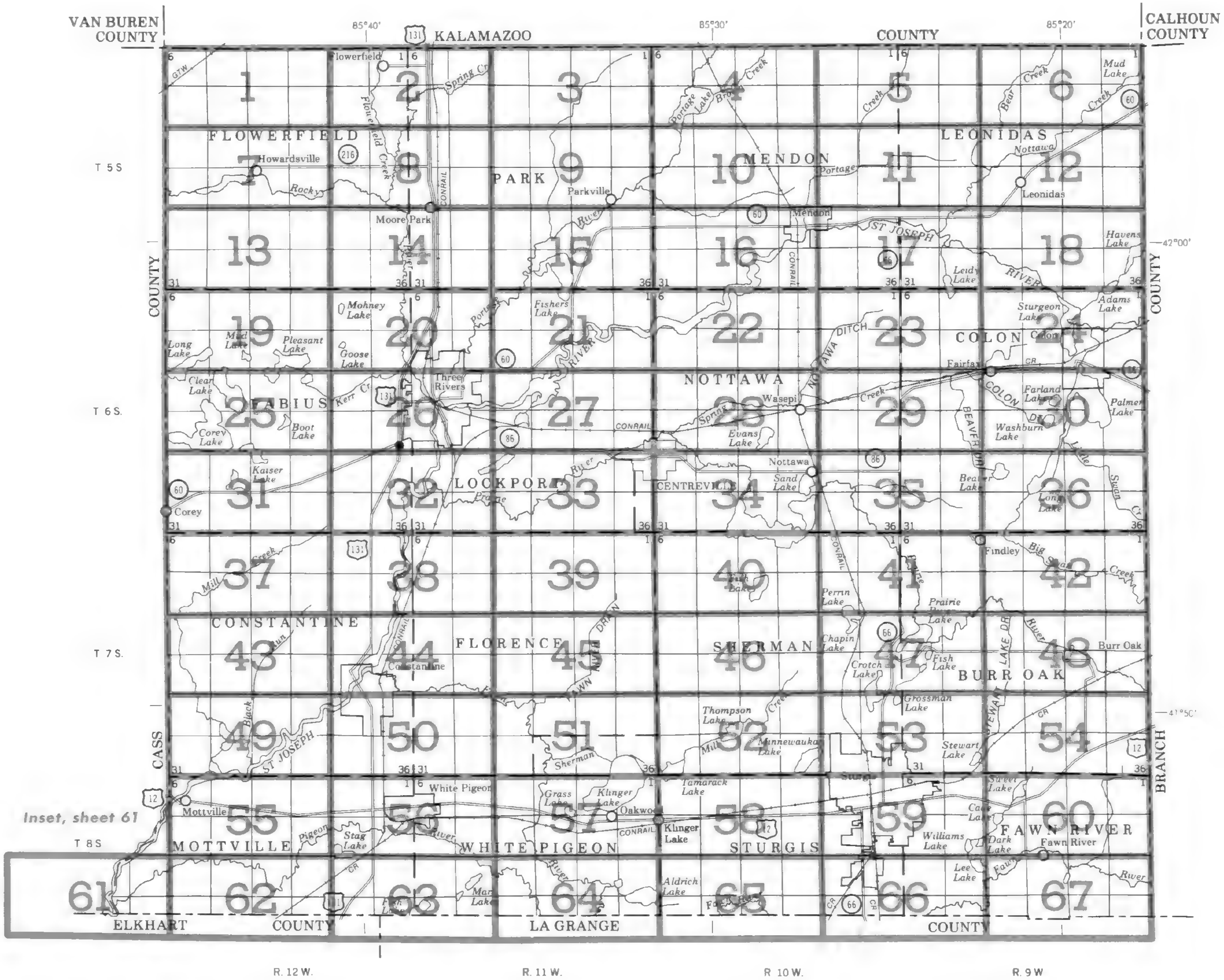
INDEX TO MAP SHEETS
ST. JOSEPH COUNTY, MICHIGAN

Scale 1:190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

N



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a capital letter. The numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
2	Histosols and Aquents, ponded
4B	Oshtemo sandy loam, 0 to 6 percent slopes
4C	Oshtemo sandy loam, 6 to 12 percent slopes
4D	Oshtemo sandy loam, 12 to 18 percent slopes
5B	Spinks loamy sand, 0 to 6 percent slopes
5C	Spinks loamy sand, 6 to 12 percent slopes
5D	Spinks loamy sand, 12 to 18 percent slopes
8A	Nottawa sandy loam, 0 to 3 percent slopes
9A	Elston sandy loam, 0 to 3 percent slopes
10B	Hillsdale sandy loam, 2 to 6 percent slopes
10C	Hillsdale sandy loam, 6 to 12 percent slopes
10D	Hillsdale sandy loam, 12 to 18 percent slopes
12A	Brady sandy loam, 0 to 2 percent slopes
13	Granby sandy loam
14	Sebewa loam
15	Cohoctah loam
16B	Elmdale sandy loam, 1 to 6 percent slopes
17B	Teasdale sandy loam, 0 to 4 percent slopes
18	Barry loam
19	Houghton muck
20A	Bronson sandy loam, 0 to 3 percent slopes
21A	Matherton loam, 0 to 3 percent slopes
24	Adrian muck
25	Pits
26	Palms muck
27B	Kalamazoo loam, 0 to 6 percent slopes
27C	Kalamazoo loam, 6 to 12 percent slopes
28B	Riddles sandy loam, 2 to 6 percent slopes
28C	Riddles sandy loam, 6 to 18 percent slopes
29B	Schoolcraft loam, 0 to 4 percent slopes
30B	Urban land-Oshtemo complex, 0 to 6 percent slopes
31B	Udorthents, loamy
32	Dumps
33A	Urban land-Elston complex, 0 to 3 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot < 3 acres in size

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (17B 10C)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

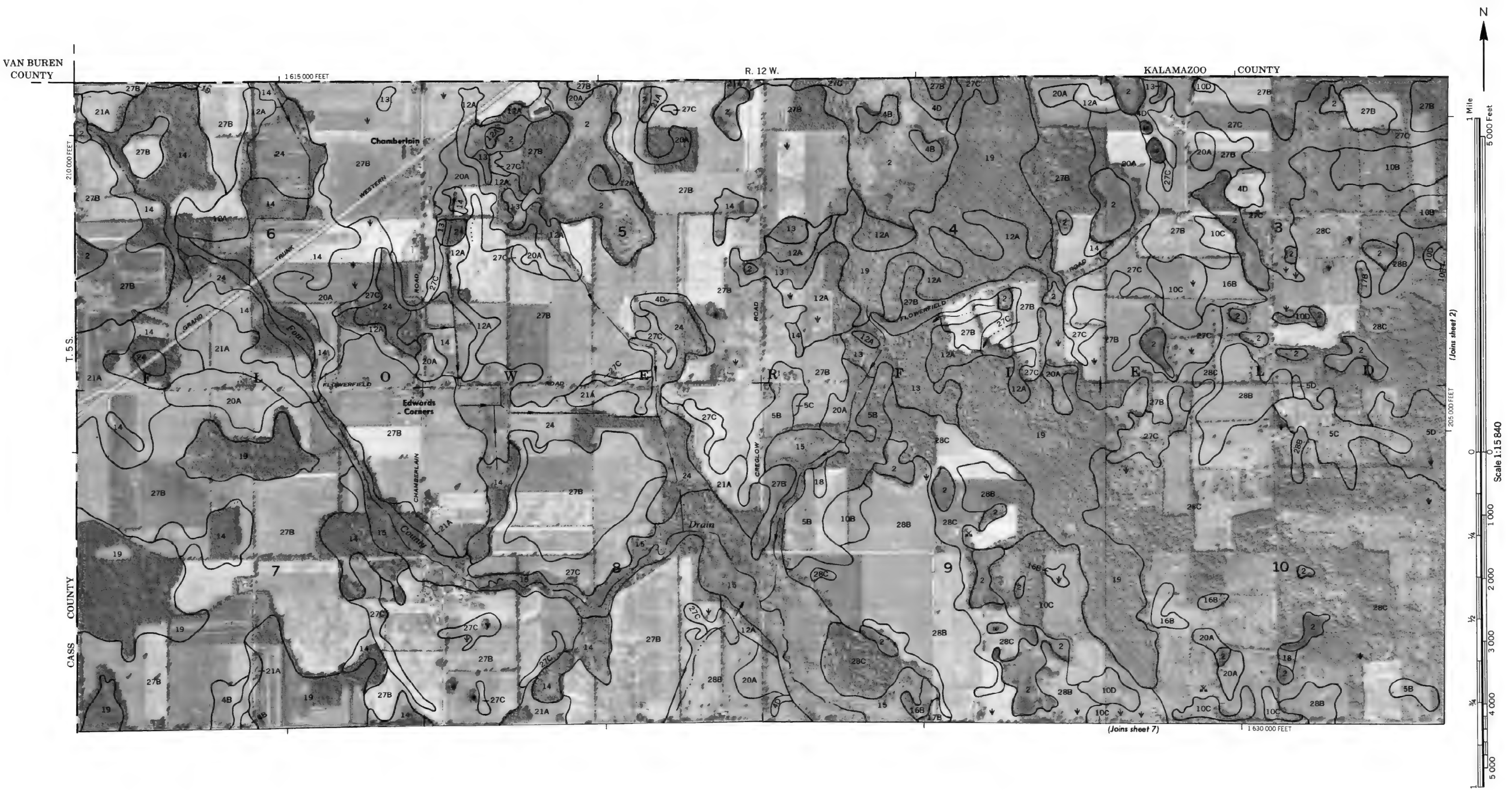
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) (S)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Spot of cut and fill land up to 5 acres in size



ST. JOSEPH COUNTY, MICHIGAN NO. 1

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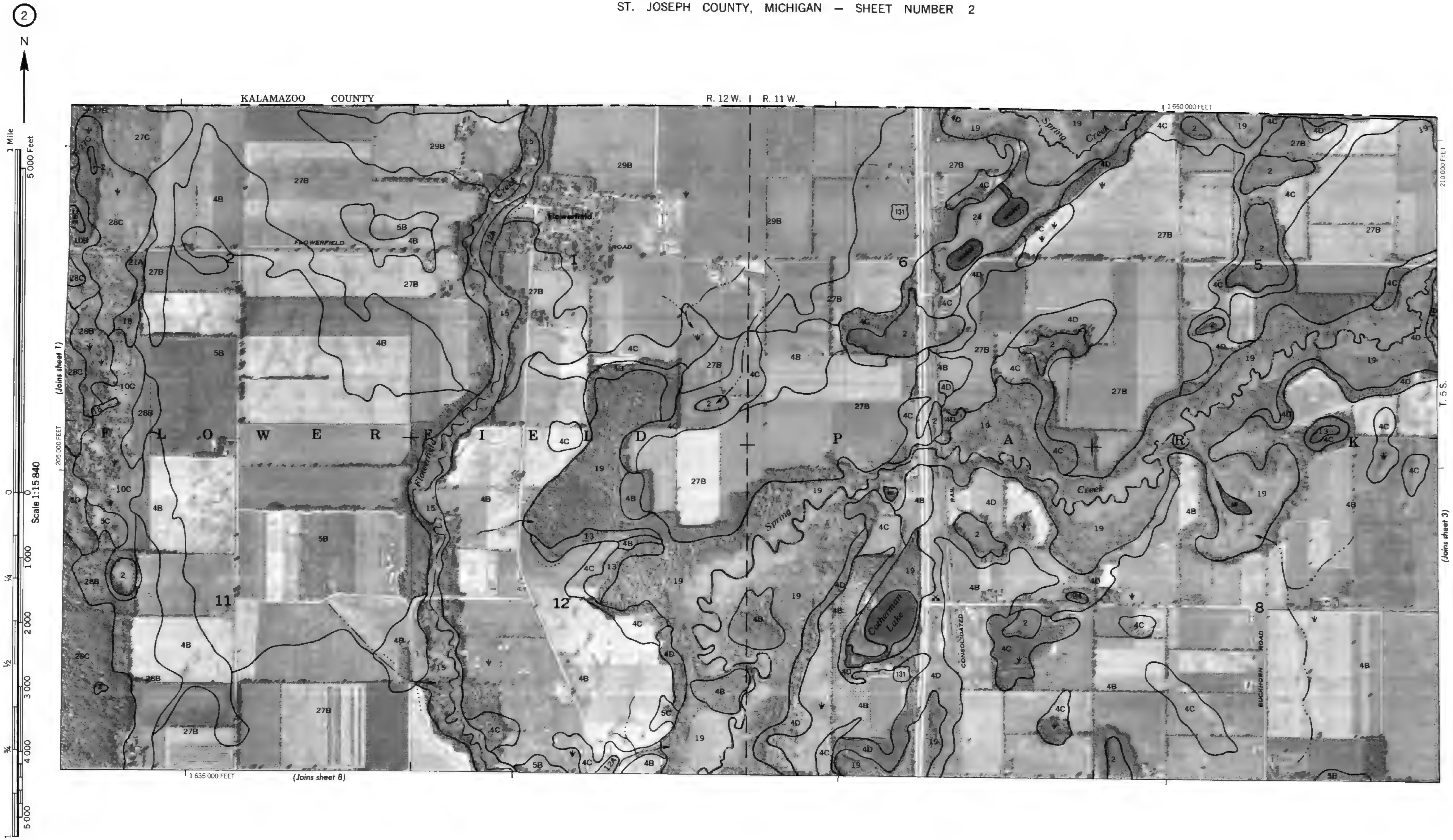

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ST. JOSEPH COUNTY, MICHIGAN NO. 2

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ST. JOSEPH COUNTY, MICHIGAN NO. 5

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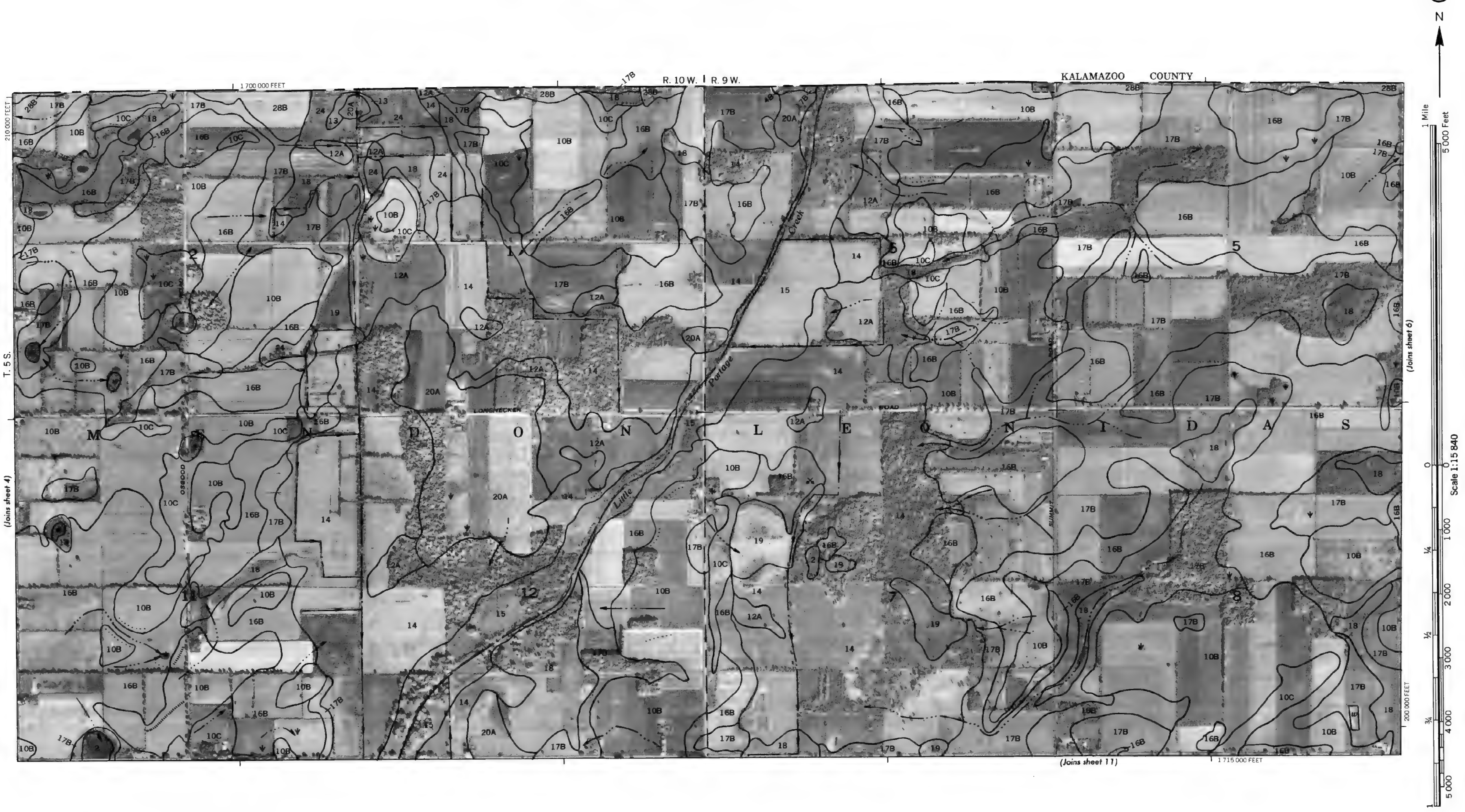

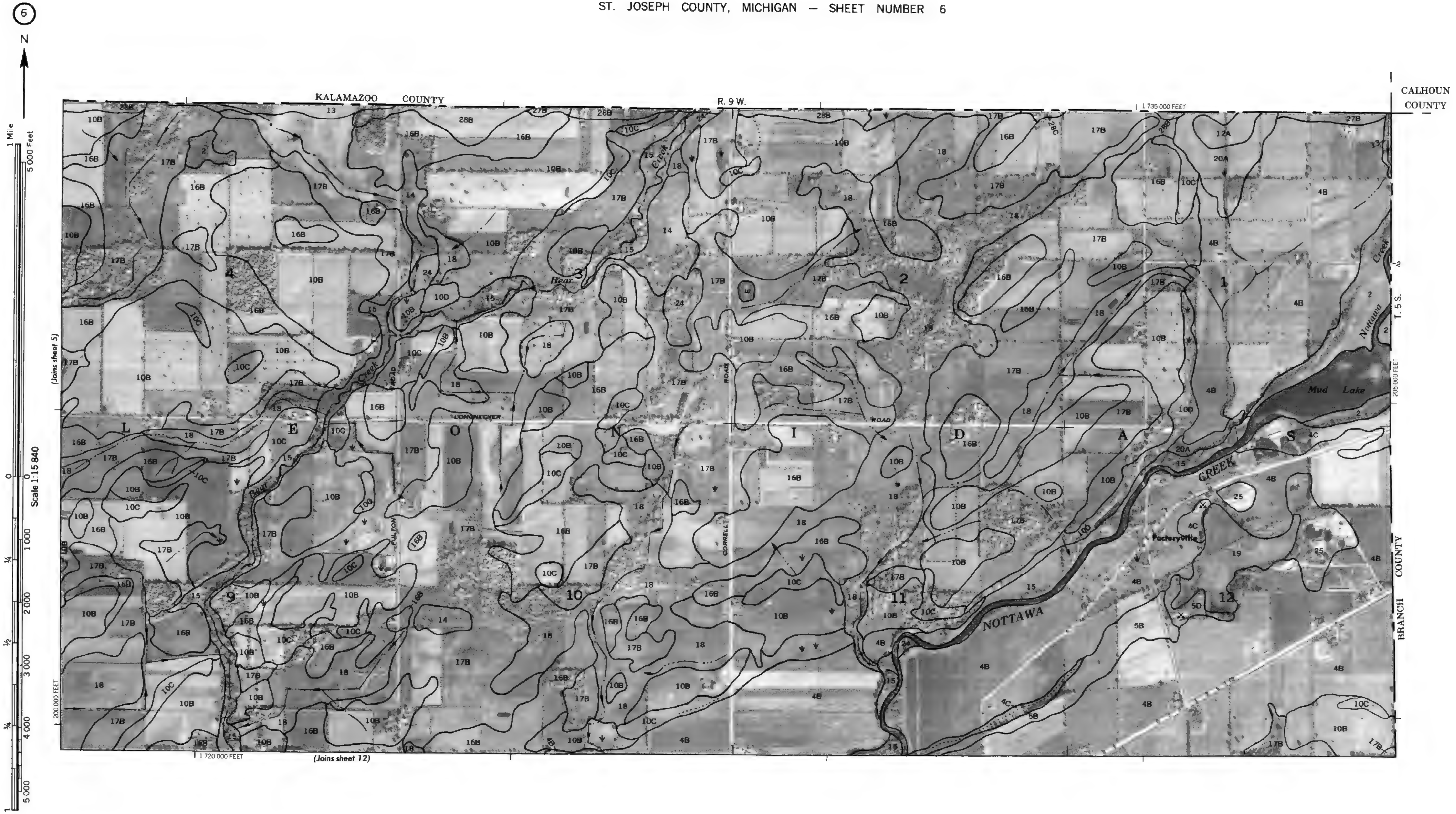

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ST. JOSEPH COUNTY, MICHIGAN NO. 7

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ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 8

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ST. JOSEPH COUNTY, MICHIGAN NO. 8

ST. JOSEPH COUNTY, MICHIGAN NO. 9

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ST. JOSEPH COUNTY, MICHIGAN NO. 11

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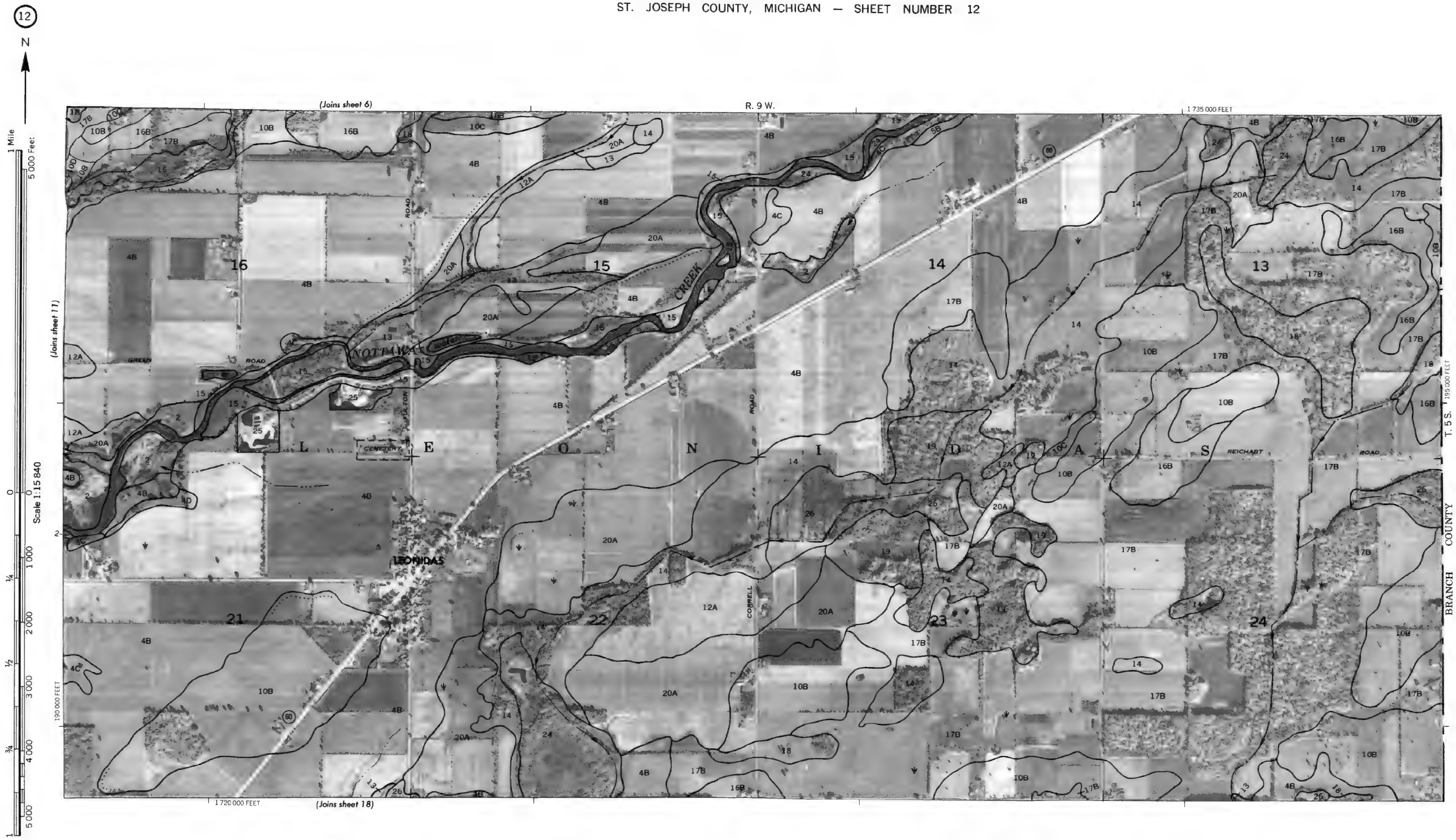

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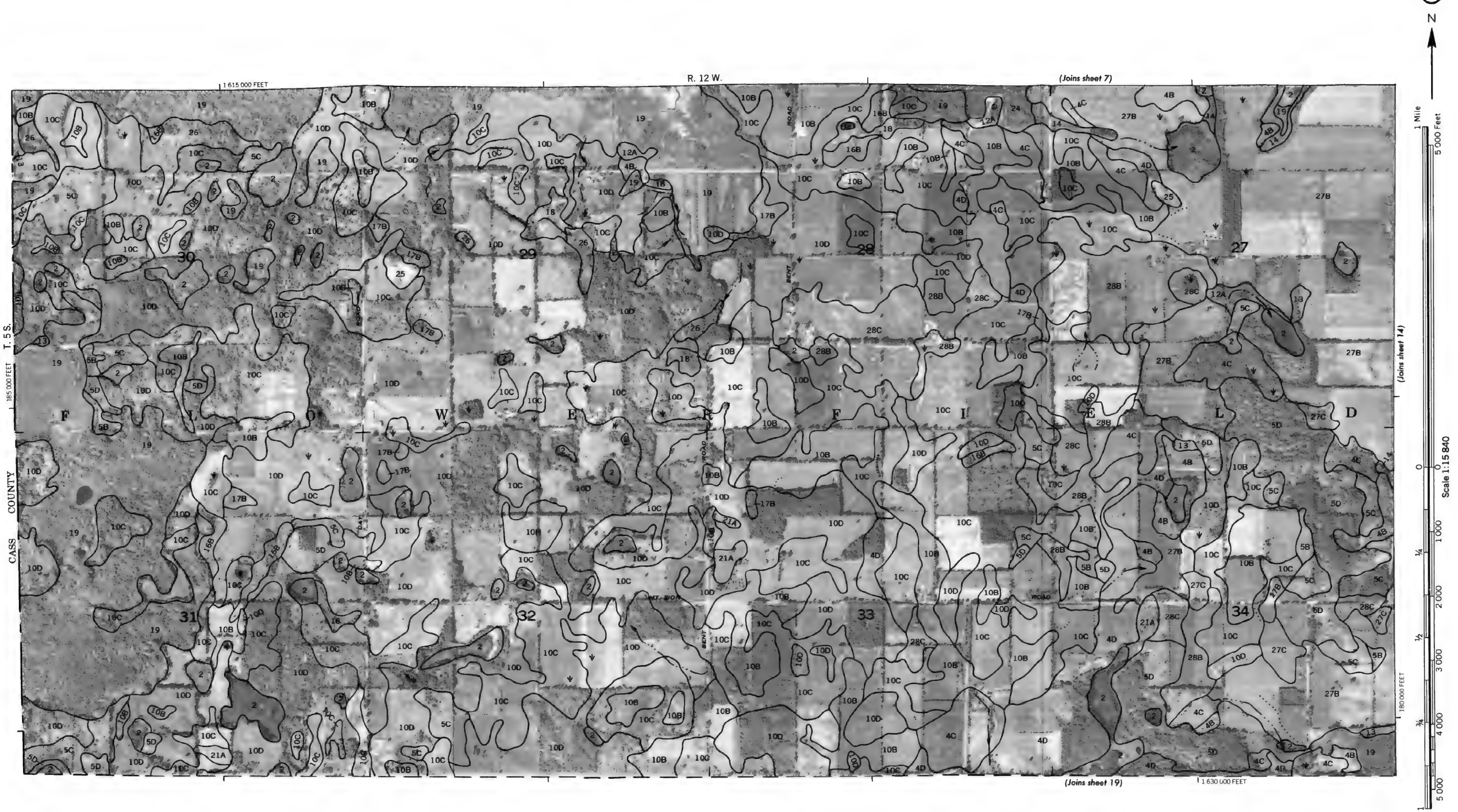
ST. JOSEPH COUNTY, MICHIGAN NO. 12



ST. JOSEPH COUNTY, MICHIGAN NO. 13

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ST. JOSEPH COUNTY, MICHIGAN NO. 14

ST. JOSEPH COUNTY, MICHIGAN NO. 15

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ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 16

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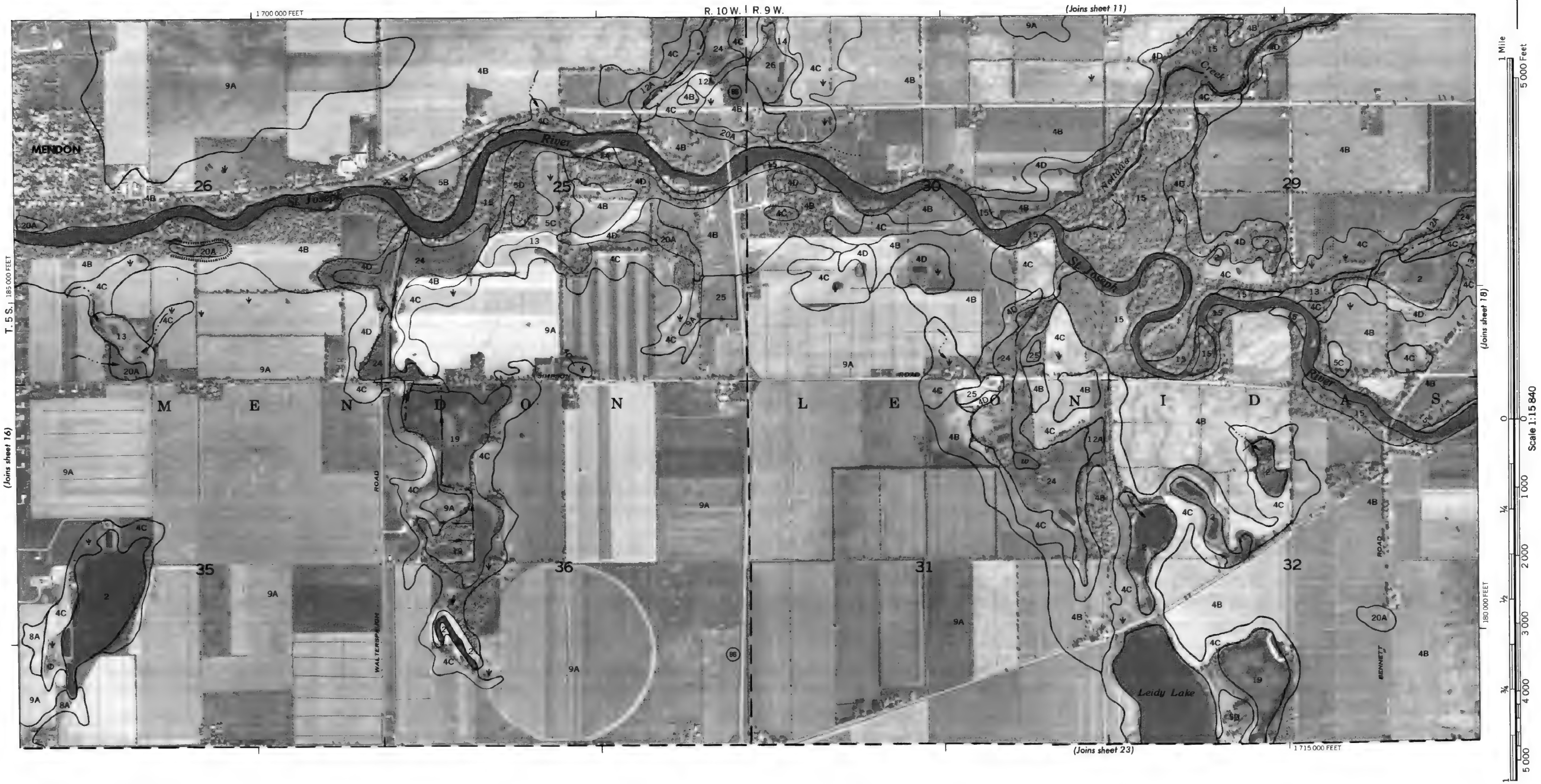
ST. JOSEPH COUNTY, MICHIGAN NO. 16



ST. JOSEPH COUNTY, MICHIGAN NO. 17

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18

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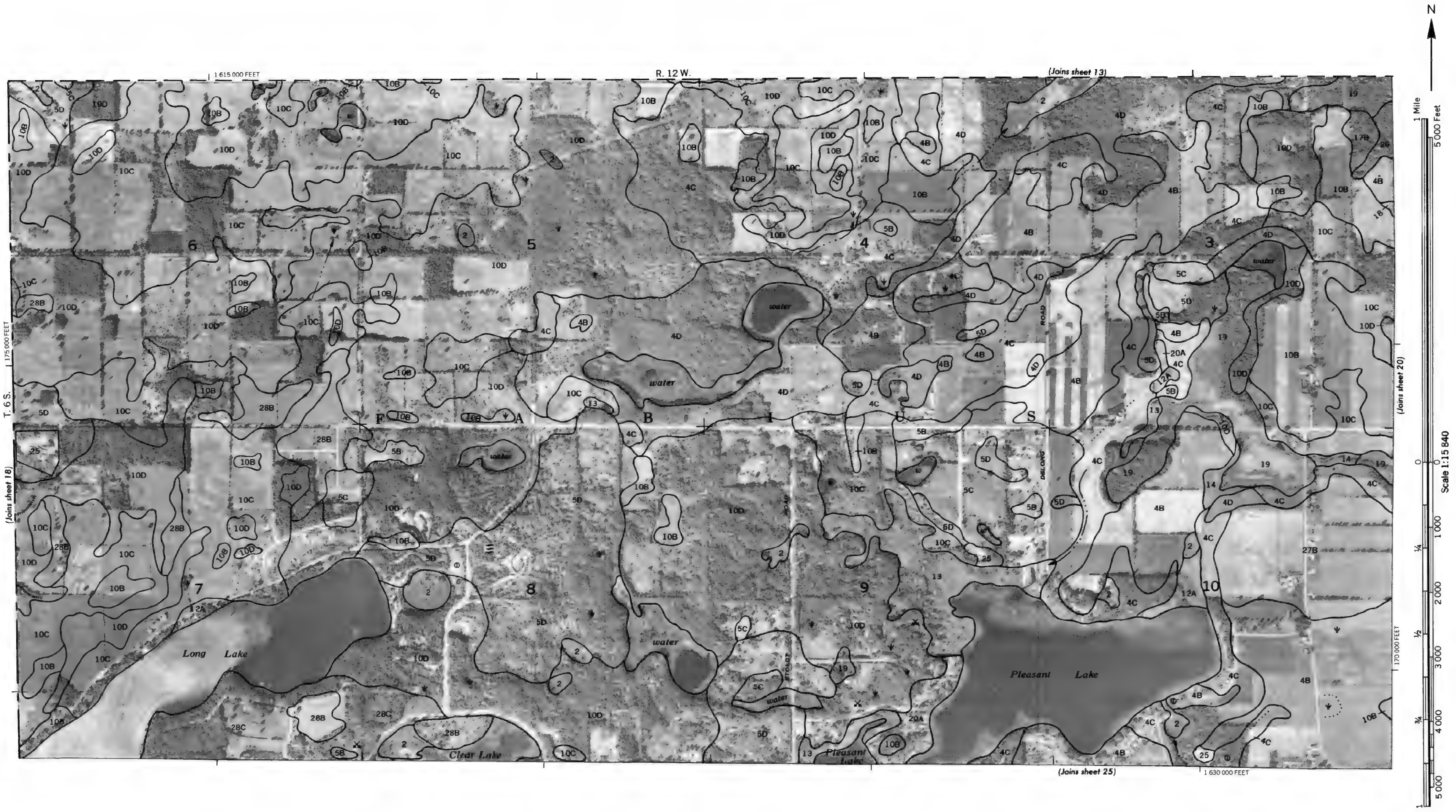
ST. JOSEPH COUNTY, MICHIGAN NO. 18



ST. JOSEPH COUNTY, MICHIGAN NO. 19

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ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 20

N

1 Mile
5 000 Feet
Scale 1:15 840

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21

ST. JOSEPH COUNTY, MICHIGAN NO. 21

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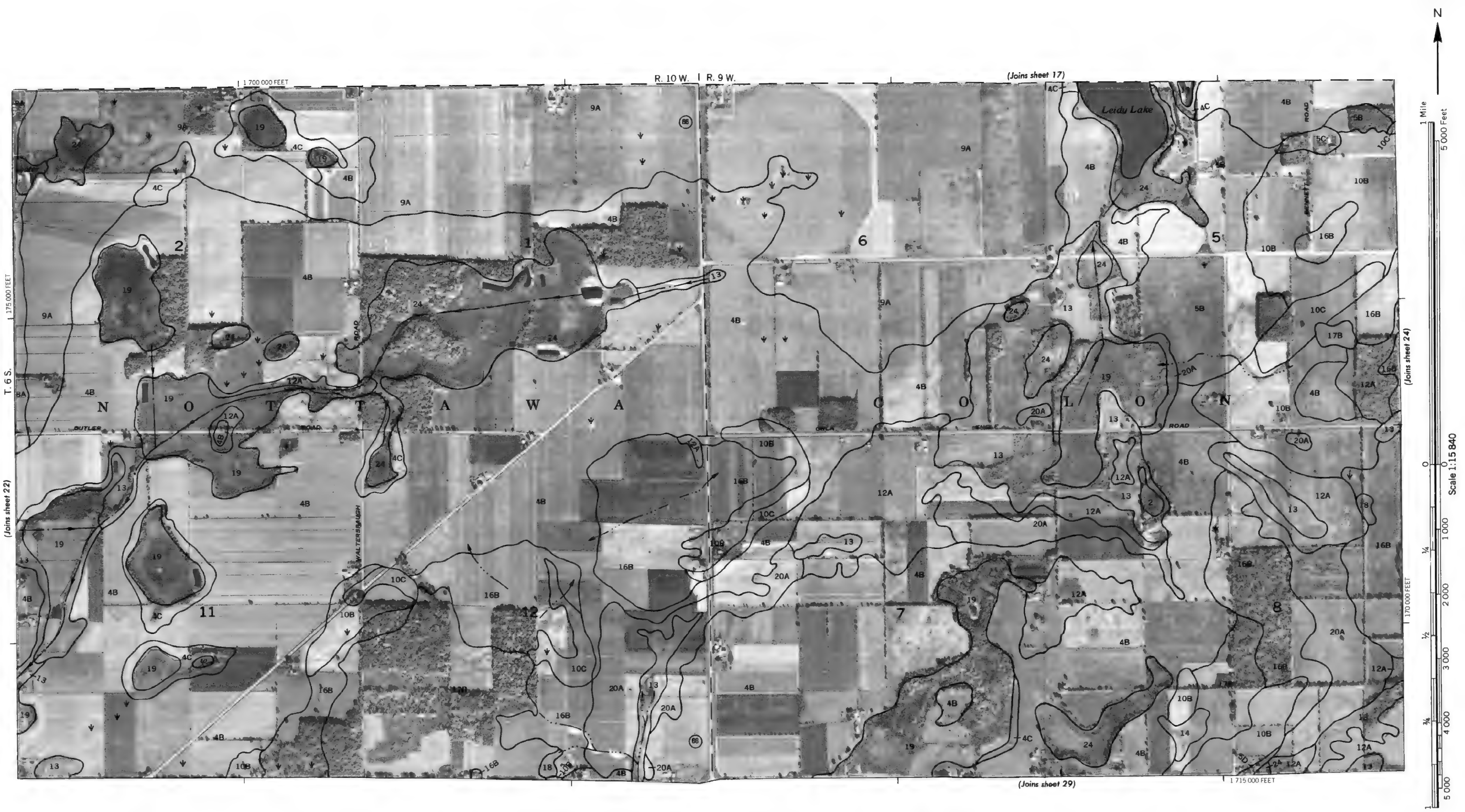

ST. JOSEPH COUNTY, MICHIGAN NO. 23

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ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 24

ST. JOSEPH COUNTY, MICHIGAN NO. 24

ST. JOSEPH COUNTY, MICHIGAN NO. 25

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ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 26

ST. JOSEPH COUNTY, MICHIGAN NO. 27

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ST. JOSEPH COUNTY, MICHIGAN NO. 29

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N

1 Mile
5 000 Feet
Scale 1:15 840
0 1 000 2 000 3 000 4 000 5 000
¼ ½ ¾ 1

(Joins sheet 24)
R. 9 W.
1 735 000 FEET
(Joins sheet 29)
165 000 FEET
160 000 FEET
T. 6 S.
BRANCH COUNTY

1 720 000 FEET
(Joins sheet 36)

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

31

N

ST. JOSEPH COUNTY, MICHIGAN NO. 31

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1 Mile
5 000 Feet
0 ¼ ½ ¾ 1 Mile
0 1000 2000 3000 4000 5 000 Feet
Scale 1:15 840

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ST. JOSEPH COUNTY, MICHIGAN NO. 33

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ST. JOSEPH COUNTY, MICHIGAN NO. 35

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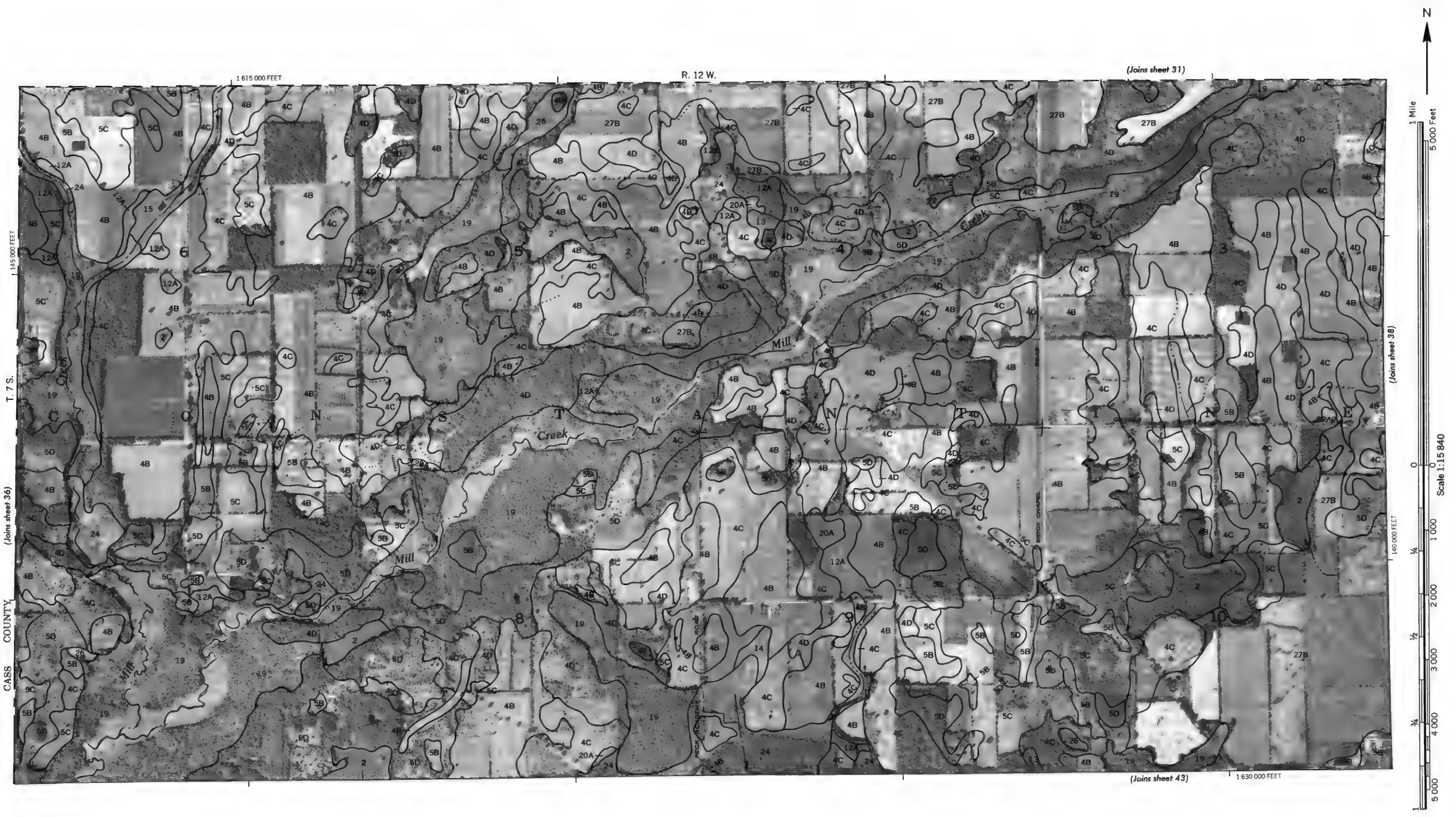
ST. JOSEPH COUNTY, MICHIGAN NO. 36



ST. JOSEPH COUNTY, MICHIGAN NO. 37

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 38

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ST. JOSEPH COUNTY, MICHIGAN NO. 38


39
N
R. 11 W.
T. 7 S.
1 655 000 FEET
145 000 FEET
140 000 FEET
1 670 000 FEET
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 45)
FLORENCE
ROAD
water
1 Mile
5 000 Feet
Scale 1:15 840
ST. JOSEPH COUNTY, MICHIGAN NO. 39
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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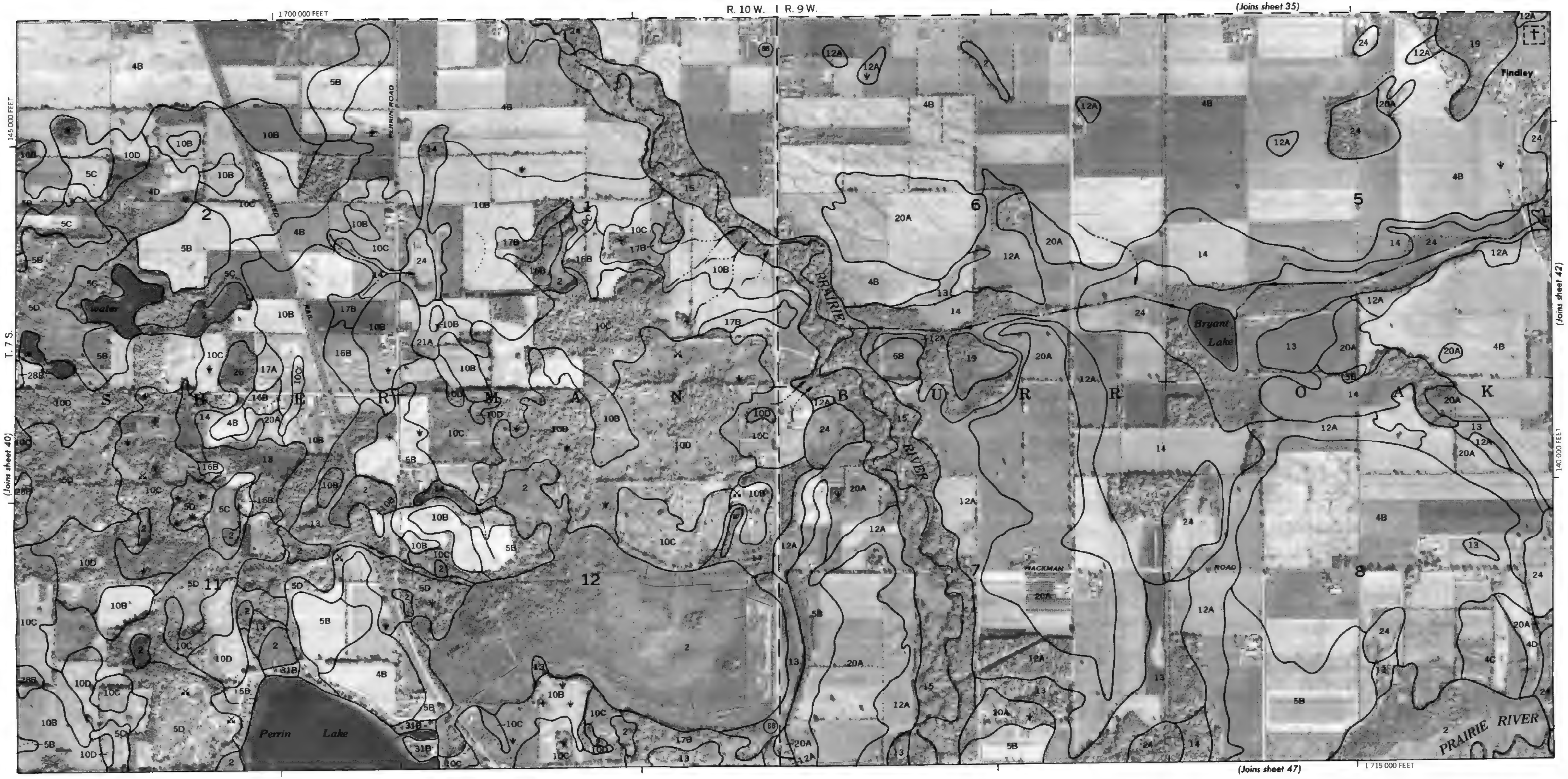
41

N



Scale 1:15 840

1 Mile

5 000 Feet

ST. JOSEPH COUNTY, MICHIGAN NO. 41

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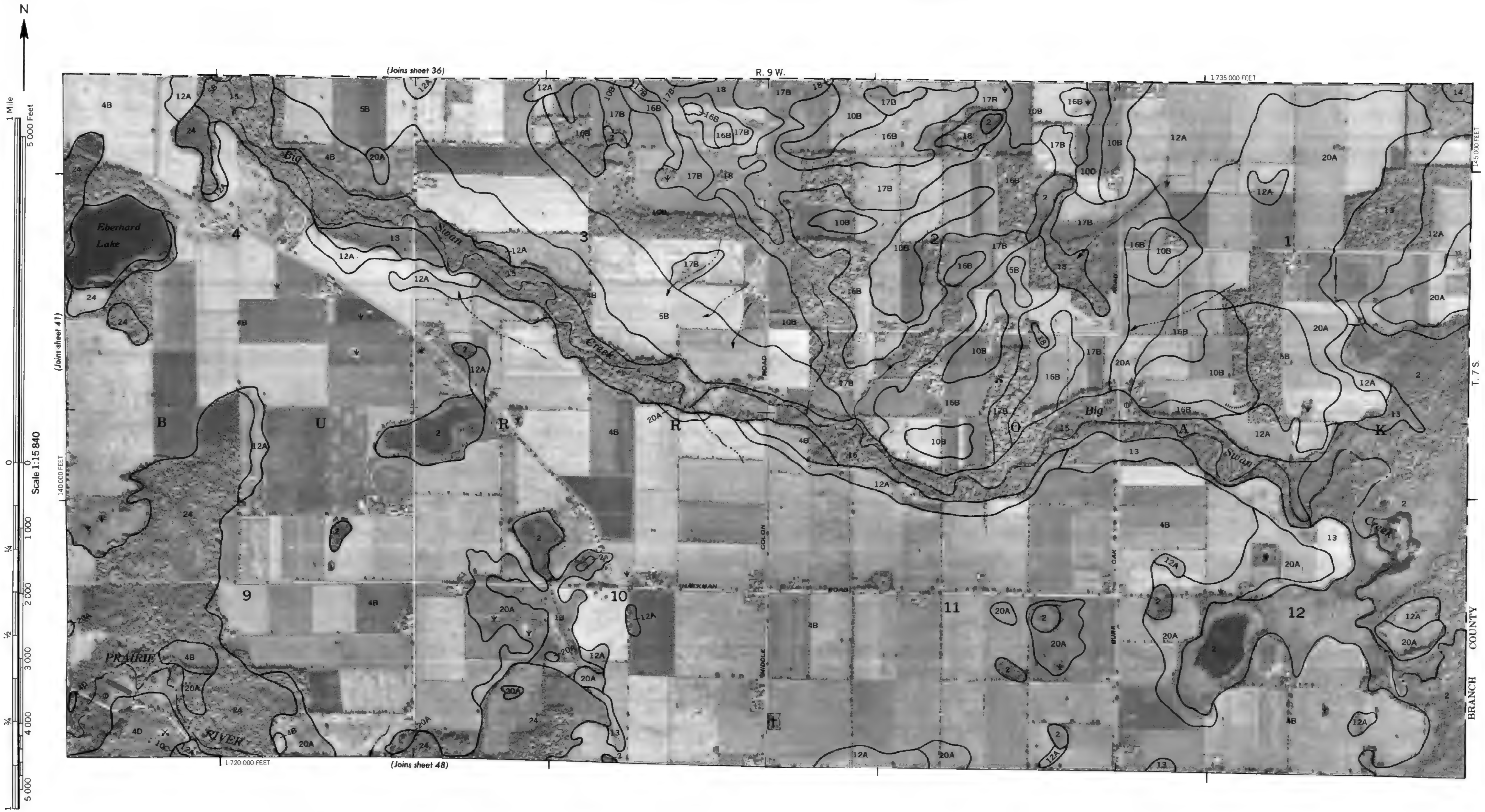

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ST. JOSEPH COUNTY, MICHIGAN NO. 42

ST. JOSEPH COUNTY, MICHIGAN NO. 43

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ST. JOSEPH COUNTY, MICHIGAN NO. 45

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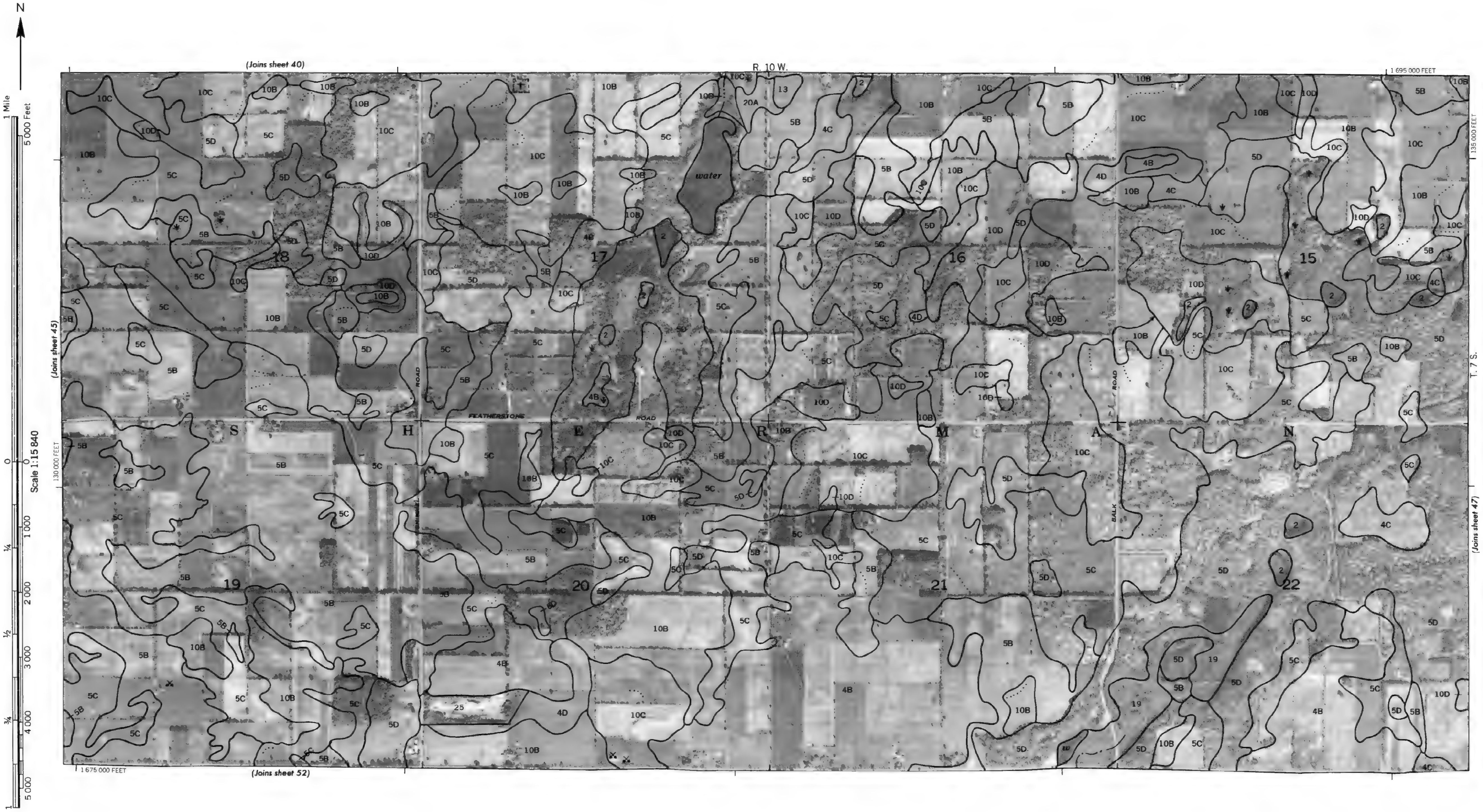

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ST. JOSEPH COUNTY, MICHIGAN NO. 47

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ST. JOSEPH COUNTY, MICHIGAN NO. 48

N

1 Mile
5 000 Feet
Scale 1:15 840
0 ¼ ½ ¾ 1
0 1 000 2 000 3 000 4 000 5 000

ST. JOSEPH COUNTY, MICHIGAN NO. 49

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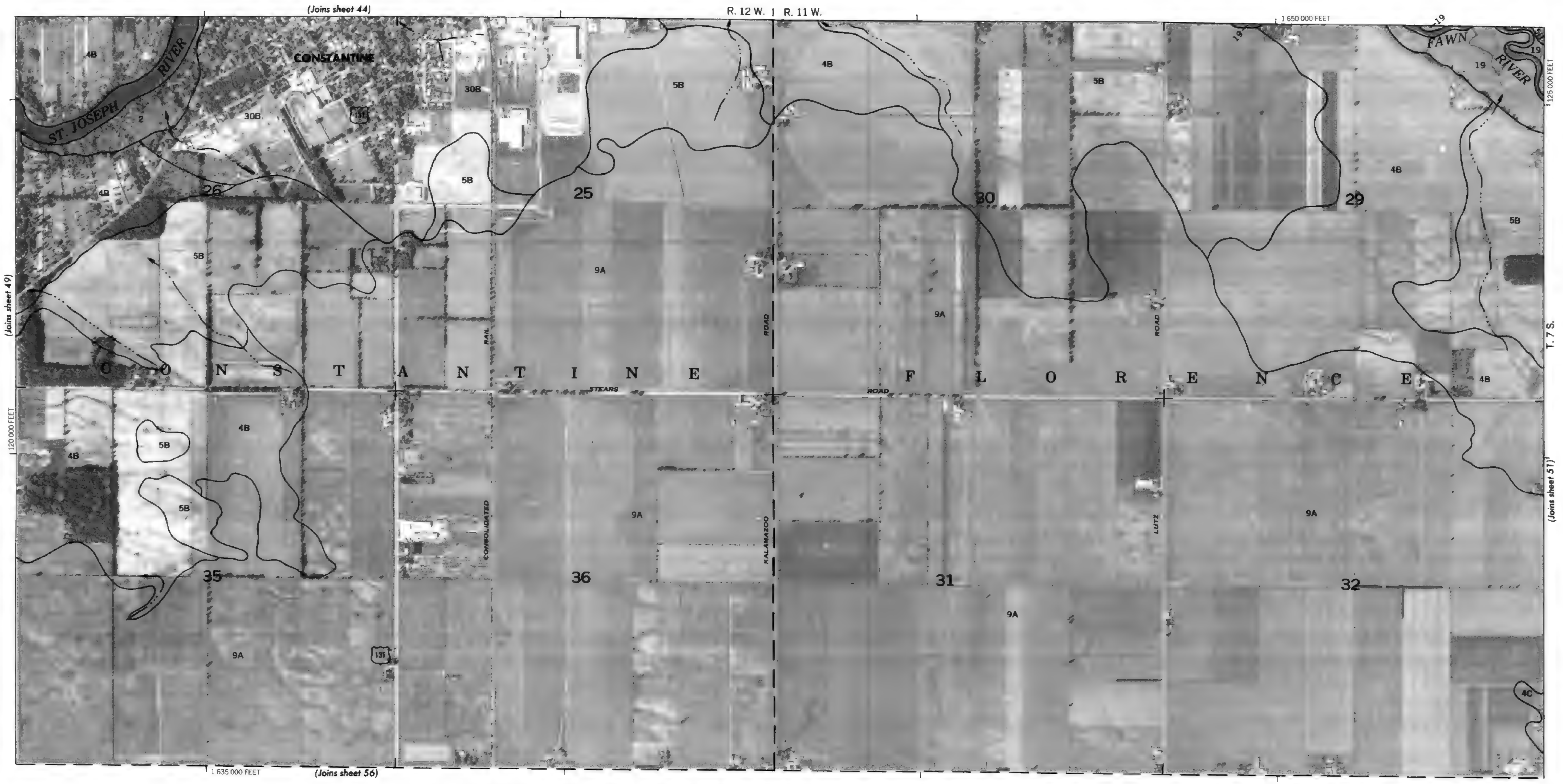
ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 50



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ST. JOSEPH COUNTY, MICHIGAN NO. 50

ST. JOSEPH COUNTY, MICHIGAN NO. 51
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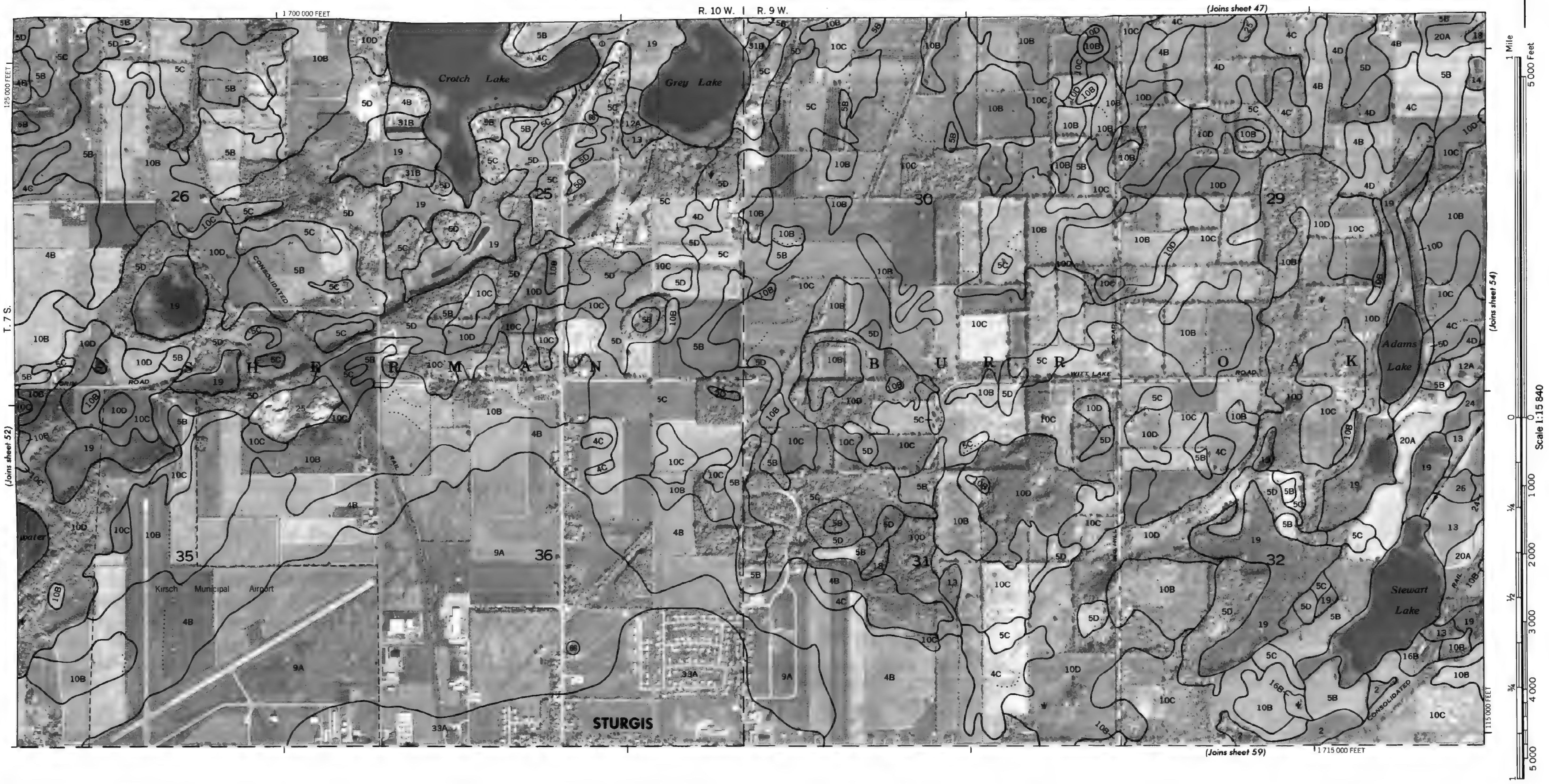
ST. JOSEPH COUNTY, MICHIGAN NO. 52



ST. JOSEPH COUNTY, MICHIGAN NO. 53

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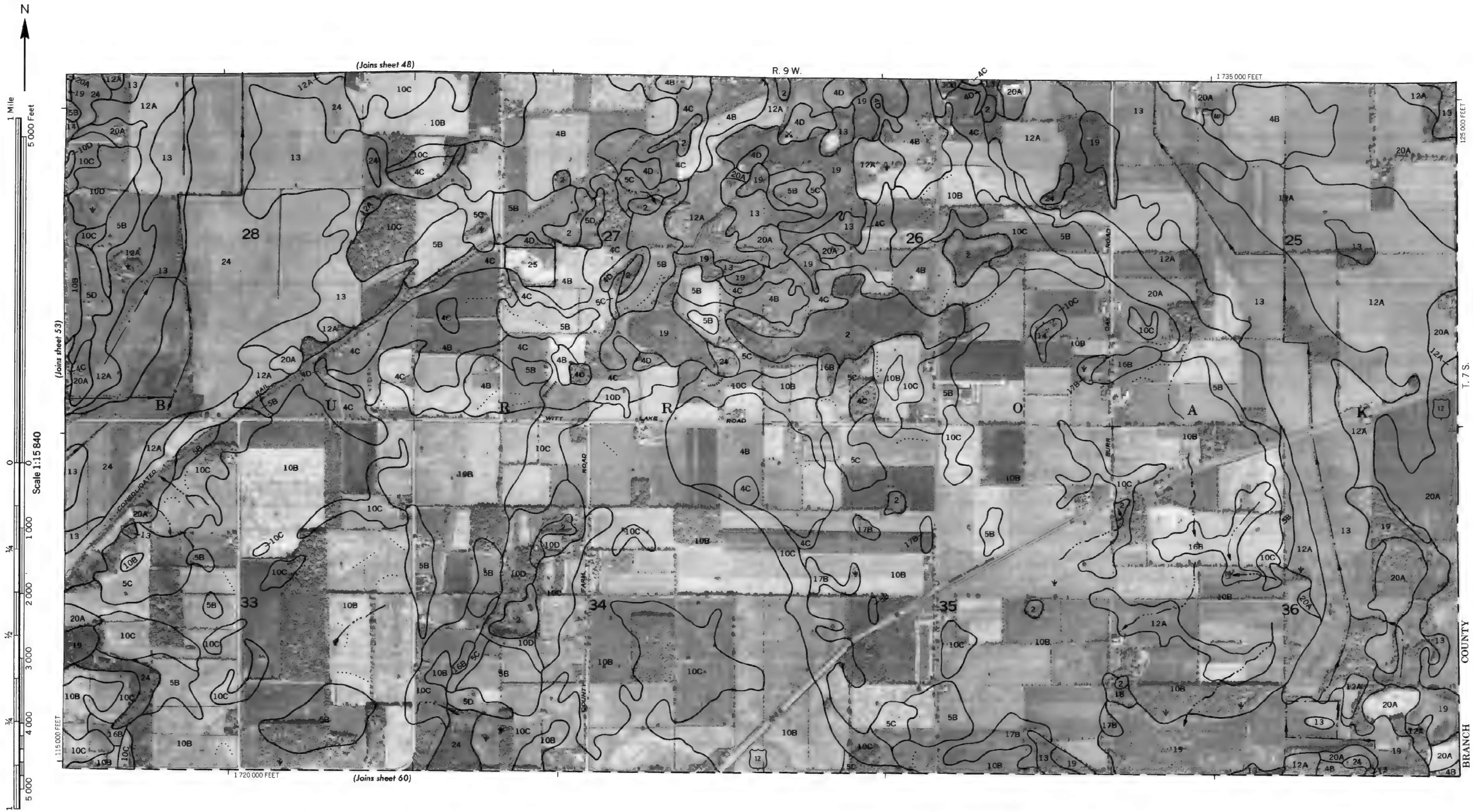
ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 54



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ST. JOSEPH COUNTY, MICHIGAN NO. 54

ST. JOSEPH COUNTY, MICHIGAN NO. 55

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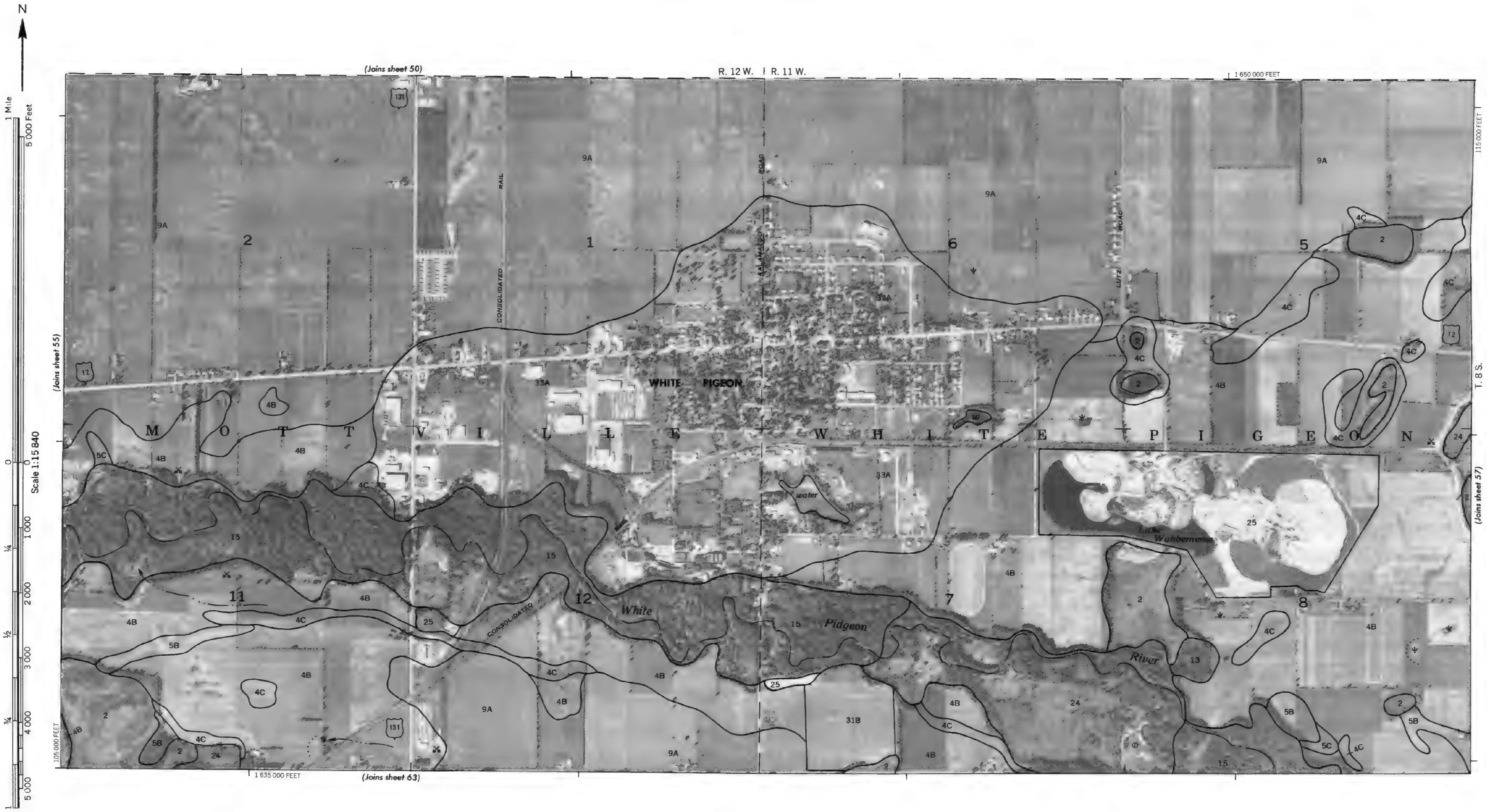

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ST. JOSEPH COUNTY, MICHIGAN NO. 57

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58

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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ST. JOSEPH COUNTY, MICHIGAN NO. 59

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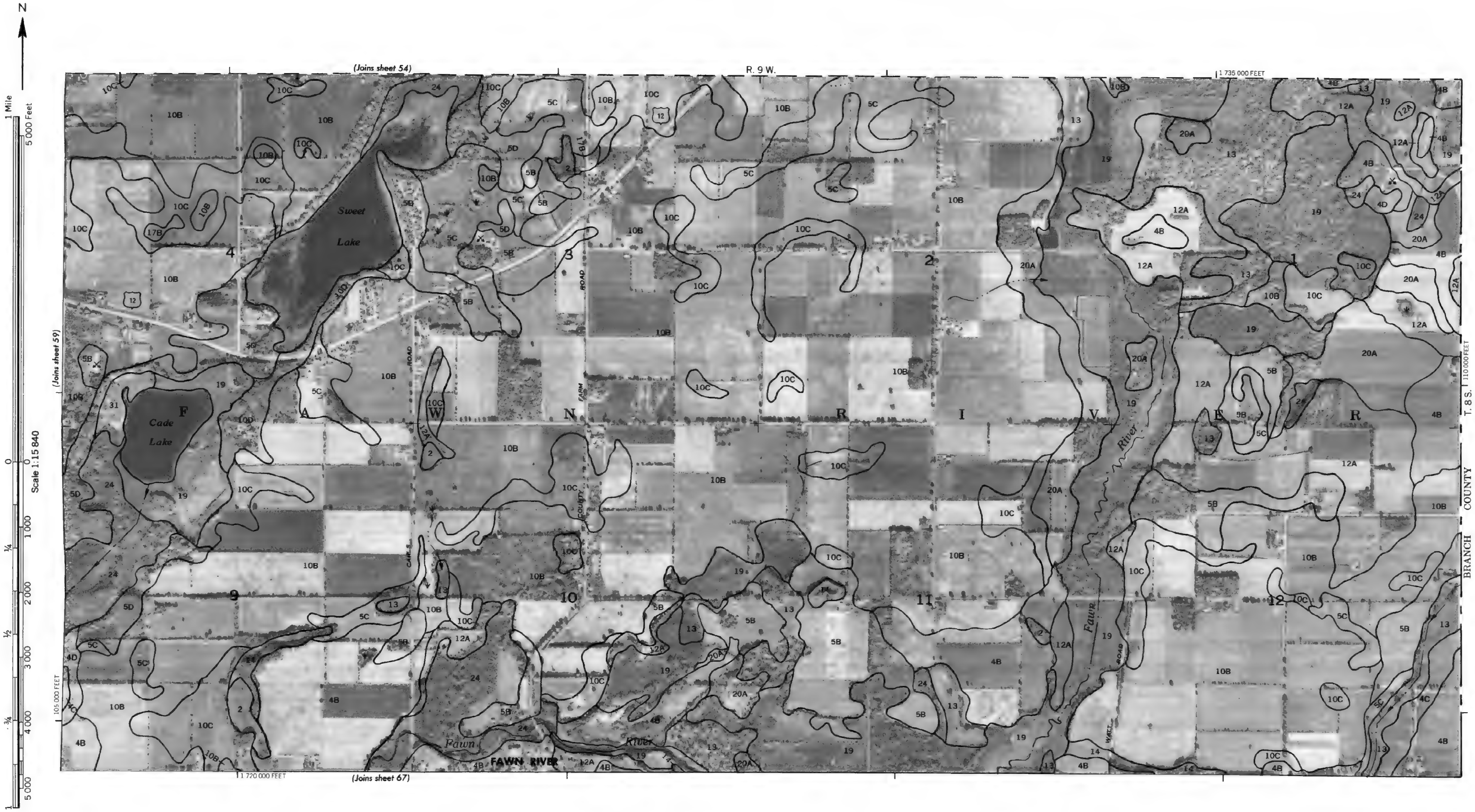

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ST. JOSEPH COUNTY, MICHIGAN NO. 61

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ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 62

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ST. JOSEPH COUNTY, MICHIGAN NO. 63

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ST. JOSEPH COUNTY, MICHIGAN — SHEET NUMBER 64

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ST. JOSEPH COUNTY, MICHIGAN NO. 65

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ST. JOSEPH COUNTY, MICHIGAN NO. 67

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